POWER

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Clinkers

By Rufus T. Strohm

IN DAYS gone by we could depend on fuel companies to send the grade of coal required. We had a chance to pick and choose, and so the stuff we used to use worked pretty well when fired. But days like those will dawn no more, for War stuck in its bloody oar and knocked things arsy-versy, and what with walk-outs at the mines and tie-ups on the railroad lines nobody shows us mercy.

Although we uttered kick and threat and smashed the rules of etiquette with "damns" and "highty-tighties," the coal that we received of late is loaded down with bone and slate, and oodles of pyrites. We did our darndest with the stuff, but when we used just air enough for burning all the gases, the ashes fused to lumps of glue that soon grew soft and trickled through the grate bars like molasses.

In every air-space it congealed, till half the openings were sealed, preventing air admission; it froze in ledges, chunks and balls until the bridge and furnace walls were in a fierce condition. And when on sultry days and nights we hoped to set the plant tc rights by putting in some quick work, the clinkers were so firmly stuck that we were wholly out of luck and ruined half the brickwork.

We gave them scads of heavy licks with hammers, sledges, bars and picks, we sawed and wrenched and chiseled; but though we twisted, gouged and pried from front to rear, from side to side, our efforts mostly fizzled. For when we'd finished our routine and got the furnace fairly clean of clinker, ash and rubble, the next fresh batch of coal we used was scarcely hot before it fused and brought the same old trouble.

I don't abhor the thought of Hell because it's peopled, so they tell, with liars, thieves and drinkers. The reason I'll fight shy of it is simply this—the brimstone pit has far too many clinkers!

Care and Maintenance of Fire-Protection Systems—I

By C. H. JENKINS
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IN THE plans of a modern plant or building as much attention is given nowadays to the protection against fire as to any part of the equipment. The entire apparatus for this purpose usually is in charge of the power-plant engineer. The investment and business must be protected against destruction by fire. Automatic protection is the most desirable, and of such equipment the automatic sprinkler system has given the best results.

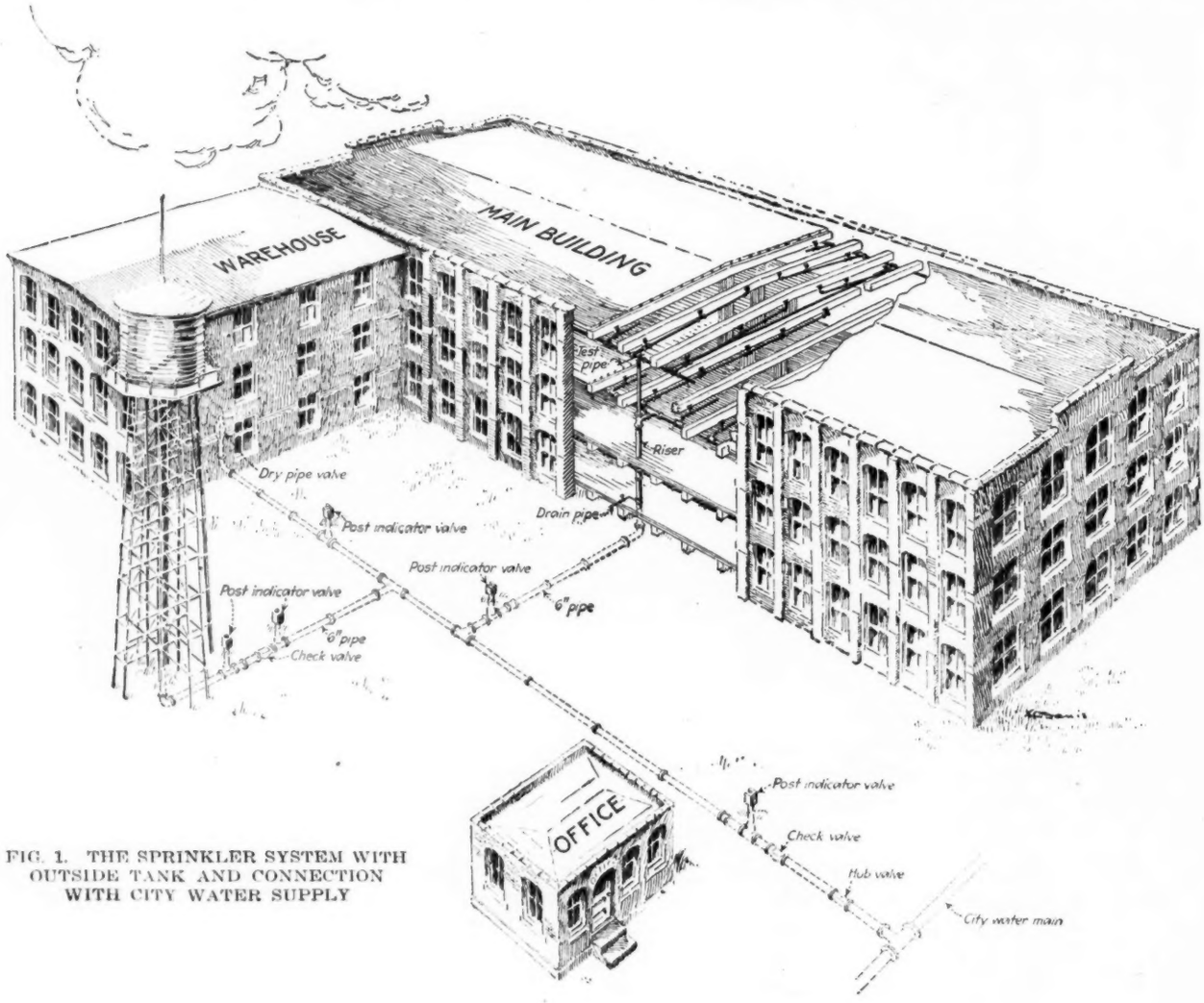


FIG. 1. THE SPRINKLER SYSTEM WITH OUTSIDE TANK AND CONNECTION WITH CITY WATER SUPPLY

Briefly, the purpose is to place sprinkler heads on pipes filled at all times with water under pressure. The sprinkler is a brass casting with a nozzle opening ½ in. in diameter and a deflector to scatter the water. The opening is kept closed by a plug or valve held in place by a strut or combination of levers. The levers are held together by a soft-soldered link which melts at from 155 to 165 deg. F. In case of fire the heat melts the solder and the levers fall apart, releasing the valve, which is forced open by the water pressure, and the water, striking against the deflector, is sprayed against anything within five or six feet on all sides of the head. The floor is wet down in a circle ten to twelve feet in diameter.

Sprinklers have been improved and perfected until they are now reliable devices. When they are correctly installed and properly maintained, they will extinguish the average fire or will at least hold it in check until further help arrives. Usually, a sprinkler in operation will create enough disturbance to attract attention.

The phrase "correctly installed" is used advisedly. Standard rules for the installation of automatic sprinklers have been published by the National Board of Fire Underwriters. They are the rules in general use today and are universally accepted as standard throughout the United States and Canada by both the installing companies and the insurance interests. Nevertheless there are, throughout the country, a number of equipments which might be called home-made imitations of

a sprinkler system. They have been installed sometimes by the owner, using his employees, and sometimes by local firms whose usual business is steamfitting or plumbing. In either case it too frequently happens that, owing to imperfect knowledge of the rules or requirements of installation, the equipment is faulty and does not allow the sprinklers to give full results. When an investment of this kind is undertaken, it is best practice to contract with a specialist in this line of work and thus obtain first-class standard equipment.

Given a system properly installed, we can expect good protection against fire, provided the equipment is well maintained. Maintenance is the vital necessity to insure full benefit from the investment. Strange as it may seem, good, first-class maintenance is not as common as it should be. Why a firm, otherwise efficient, should invest from ten to twenty thousand dollars in a means of fire protection and then leave the system to take care of itself is difficult to understand. The system is too often left in the care of someone who does not understand it and is not particularly interested in it. In either case the investment is apt to be nullified by the apparatus being out of service when the fire comes.

Engineers and the mechanical department are usually pretty busy people, and the fire-protection system, being an addition to the usual equipment, is likely to receive attention only when there is nothing else pressing. It might be well for those in charge to bear in mind that if the plant burns down, numbers of people will lose their jobs. A small amount of time spent in looking over the system at frequent intervals will guard against such contingency.

"Unsatisfactory" Fires.

The National Fire Protection Association, which keeps as complete a record of fires as is possible, reports for the years 1897 to 1919 inclusive 1,017 "unsatisfactory" fires in properties equipped with sprinklers. Of that number 283, or 27.9 per cent, were due to the water being shut off part or all of the sprinkler equipment; that is, a valve in the pipe feeding water to the sprinklers was shut when the fire started. Obviously, if there is no water on the sprinklers they cannot extinguish fires.

Of the remaining cases 36 were due to portions of the piping system being allowed to freeze so that water could not pass through to the sprinklers when the heads opened. The others were due to miscellaneous causes. The large losses represented by these fires were due directly to unsatisfactory maintenance.

During the year 1919 one inspection department covering five states reports impairments of fire protection coming to its notice during the year as follows:

Valves Shut	Tanks Low or Empty	Pressure Tanks, Poor Condition	Dry Valves Out of Order	Alarm Valves Out of Order	Fire Pumps Poor Condition
438	329		66	109	46

Another department covering five other states reports the following:

Valves Shut	Tanks Low or Empty	Pressure Tanks Poor Condition	Dry Valves Out of Order	Alarm Valves Out of Order	Fire Pumps Poor Condition
323	41	31	56	613	60

These were all actual impairments found at the time of inspection by representatives of the two departments. Note the large number of valves found closed in both cases.

In 1917 a loss of about one million dollars occurred in a sprinklered property. The piping in one section had frozen, and the water has been shut off to make repairs. Repairs were made, but water was not turned on the sprinklers on account of very cold weather. It was Saturday afternoon and only a few hands were on the premises. A fire occurred in the section where the water was shut off, and the sprinklers being out of service, there was nothing to stop it. By the time it was discovered and help arrived, the fire was so well started that it could not be controlled. The greater part of the plant was destroyed.

In another instance a valve was shut for repairs and the fire started so near it that, when discovered, no one could reach the valve. The building burned down. These are but two of numerous similar cases. The lesson is clear. There must not be the least carelessness when repairs are being made to fire-protection apparatus.

When a large number of sprinklers are shut off, it is best practice to keep a man at the closed valve ready to turn it on. A man working near-by may be used for the same purpose. In any event the water should be turned into the pipes as soon as possible.

It often happens also that valves become closed for no reason that can be discovered. A case is recalled where, in a textile property, a sprinkler valve was found shut; no one had any idea how it became shut. The foreman of the room, however, found the explanation. The valve was of the ordinary type with handwheel to operate and located close to the outside wall, about five feet from the floor. The room was used for spinning yarn. The foreman noticed that when the spinning frame was running well, the girl operator would step back and, by reaching up and taking hold of the valve wheel, would hang part of her weight on it, supposedly to rest herself. The valve was so placed that she had always to approach it the same way and each time she gave the wheel a slight turn. In the course of time the valve became shut. An inspection of the system found it in that condition. Numerous cases like these have been found. The only safeguard is frequent and careful inspection of the apparatus to make sure that it is all in order.

Closed valves have been the cause of most large sprinklered-property losses.

The engineer, master mechanic or whoever has charge of such a system should conscientiously study it until familiar with it and its operation. He should at frequent stated intervals make a careful examination of the whole equipment.

The Sprinkler System

Fig. 1 shows a sprinkler layout equipped with automatic sprinklers. A standard system includes complete equipment of sprinklers installed according to the standard rules, and two standard water supplies.

The supplies are called the primary and secondary supplies. The primary supply should be able to give a normal water pressure of 25 lb. *on the highest sprinklers.* It should also have capacity sufficient to supply at least ten opened sprinklers at a pressure of 12 to 15 lb. with water flowing. In properties of especially inflammable occupancy a greater capacity would be required. The secondary supply, usually either a gravity tank or pump, should have ample capacity to sup-

plement the primary supply. Either should be capable of taking care of the system alone if the other, for any reason, is out of service; normally, they work together. The capacities and arrangement of the various supplies used will be dealt with later.

The system shown in Fig. 1 has a connection from the public water works, also a gravity tank on a trestle. These are connected to a 6-in. underground pipe in the yard. Branches run from this main feed pipe to each building, in each of which there is an outside valve to shut off the water when necesasry. The branches run to a central distributing point in each building, where an upright pipe or riser carries the water to each floor. The distributing pipes branch out from the riser in each story. An alarm valve is sometimes inserted in each riser, which rings a gong when water passes through it. There may also be another gate valve inside at the base of the riser, but usually one valve is enough. The building called warehouse* is equipped with a so-called dry-pipe system, air being kept in the pipes to prevent freezing in cold weather.

Testing a New System

Before a system of this kind is turned over to an owner, it is the practice to test it out at high hydraulic pressure. It is usual to test inside pipe at 150 lb. per sq.in. for one hour, and outside pipe at the same pressure for two hours. These tests should reveal flaws in material, also poor workmanship.

When the system has been completed, the engineer or whoever is to have charge of it should make it a point to go over the installation with the sprinkler-company foreman. He should carefully examine it and understand it. The owner must, of necessity, leave the care of such apparatus to the mechanical department. It becomes part of the latter's duty, therefore, to learn what has been provided and how it should operate. On a new installation it would be well to make the following tests in company with the sprinkler foreman:

If there is any underground pipe, the hydrants, if any, should be opened and flushed out. The water flowing out should be carefully observed. If it is clear and flows in a strong stream, a clean well-laid pipe is indicated. Too often, however, considerable dirt, gravel and other foreign material find their way into underground pipe. If not washed out, they may later be carried up into the sprinkler pipes and perhaps obstruct them. If the streams contain dirt and gravel, let them run until the water comes clear.

There have been cases where gloves, parts of overalls, oakum, tools and other odds and ends have been left in the pipe and were washed out through hydrants. Sometimes they obstruct the flow and an unsatisfactory stream is obtained. In that case it is necessary to take the pipe apart until the obstruction is found. Poorly run lead joints sometimes deposit large pieces of lead inside the pipe, which form obstructions. The time to find defects of this kind is before the work has been accepted, and they can be found only by testing.

Flushing the Drains

After flushing the hydrants, the drain at the bottom of each riser should be opened and flushed. There should be a 2-in. drain pipe and gate valve at the bottom of each riser. They can be used to make sure that a good flow of water is available up to that point. If there are no hydrants, they can be used for flushing out the main feed lines.

If drains are piped to a sewer or main drain line, care should be taken to allow for a good flow. Lines from sinks, washbowls and such other connections should contain checks, so that in testing, water will not back up and overflow. At this point on each riser there should be a pressure gage, and if alarm valves are installed in the risers, there should be two, one above and one below the alarm valve. The reason for using two gages is that alarm valves are built like check valves; that is, they allow water to flow upward but not down. If the pressure in the pipes below the alarm valve got low, the pressure above would remain the same, and one gage would not show the lowering of the pressure. In making the last-mentioned test, it would be well to note how much the flow of water, with the drain valve open, reduced the pressure, the gage under the alarm valve being the one to read.

Test Pipe at Top Should Be Opened

In addition to these tests the test pipe at the top of each system should be opened. At the highest point of the piping there is provided a ¾-in. pipe with a ½-in. bushed opening. This gives a flow equivalent to one opened sprinkler. It is provided for testing purposes and should be arranged so that water can be discharged without doing damage. A good flow of water at this point will indicate that there is water all the way up through the piping. All these tests are necessary to show that the pipework is free from obstructions. Many peculiar things happen during these installations. Stones, pieces of wood and débris are washed up into the pipes, sometimes when the water is first turned on. There have been cases where the outside indicator post valves have been set up with the valves shut, but the indicating device reading open. Valves may be defective and the discs will slip off of the stem. The valve may appear to be open, but the discs still obstruct the waterway. Pipefitters sometimes use blank gaskets of metal to close the top of the riser so that water can be turned on the systems below; occasionally, these are forgotten and left in place.

After the flowing tests have been made, it would be well to close and then open wide each valve on the system.

The alarm valves, if any, can next be tested. This can be done by opening the test pipe at the top of the system or at the same time that the flowing test is made. The alarms should begin to ring when the flow starts and should stop when it is shut off.

The dry-pipe valve should be examined and thoroughly understood. This device is used when piping is placed in unheated or cold buildings where water in the pipes is likely to freeze. By means of a mechanical or differential valve a limited air pressure in the piping will hold back the water until the air pressure is released by the opening of a sprinkler. These valves are somewhat intricate and require study, although they are nothing that a mechanical man should not be able to understand after a reasonable explanation. Carelessness or lack of understanding may easily place them out of service. See that a diagram is posted at each dry-pipe valve, explaining it and showing how to set it up.

The pressure ratio for these valves is usually 5 or 8 to 1; that is, 1 lb. of air will hold back 5 to 8 lb.

of water. To allow for air leakage, it is usually customary to carry 35 to 40 lb. air for water pressures of 60 to 110 pounds.

Valve Seats Should Be Clean

In setting up these valves, it is important to have the seats clean, free from dents or scratches and to obtain a proper adjustment of the working parts. If there are nuts or setscrews to tighten, as there sometimes are, do not force them up hard. A snug fit is all that is necessary. There should be about one pailful of water above the air valve to seal it. This is called the priming water; frequently it is forgotten, and as a result the air leaks back through the main valve casing. Air piping should not leak more than 10 lb. per week. Sometimes, when a system does not hold the air pressure, water is left in it for awhile to rust the small leaks. The practice is questionable if the leaks are of any size. The pipework should be well enough done to make the piping reasonably airtight.

After these tests and examinations have been made, further explanation should be sought if the system is not understood.

System Should Be Tested at Regular Stated Intervals

After the system has been turned over to the owner, this routine of tests should be made at regular intervals. The fact that the system is in order when delivered by the installing company is no guarantee that it will remain that way. City valves in the street sometimes are shut off by repairmen and left that way; obstructions get over the outlets from tanks. One case is recalled where because of salts in the water and sediment, which settled at a certain point, a 4-in. pipe became entirely stopped up. In another case, where a wooden tank leaked, someone poured a large amount of oatmeal into it with the idea that it would find the leaks, swell up and stop them. Just how this would have affected the piping is uncertain. It might have gotten into some of the small pipes and, together with sediment, of which there is usually a little in the pipes, have formed an obstruction. Luckily, it was discovered by inspection and cleaned out.

After going over the piping, examine the water-supply sources. In Fig. 1 they are city water-works connection and tank. The tank should be shut off while one flowing test is made to show that the water from the city is in proper volume and at good pressure, then turned on again.

There are gate valves in connection from both water-works and tank for shutting off the water; there are also check valves in each connection. These checks allow the water to flow into the system, but not the other way. The one in the water-works connection is to keep the tank water from running out into the water-works system. The one in connection from the tank is to prevent city water from rising up into the tank and overflowing it.

Tank Should Be Full and Free From Leaks

Make sure the tank is full of water and free from leaks. See that a strong and safe ladder has been provided for access to it. Make sure that the filling pipe is in order and that there is an arrangement for heating the water in cold weather to prevent freezing. See that a telltale, for showing how much water is in the tank, has been provided and is working right.

Instead of a city water-works connection direct there may be a pump. If so, look over the steam and water connections, run the pump to capacity if possible, and be sure it is working satisfactorily. An idea seems to be held in many cases that the pump or public connection is put there to fill the tank from which the water is fed to the sprinklers. That is not so. The pump or water-works connection feeds to the same main pipe that the tank does, and the water goes directly to the sprinklers.

Fig. 1 shows outside underground piping in part. In city properties there often is no yard room for outside pipe; but the arrangement in such cases is no different, the main pipes simply being run inside, usually in the basement.

Where public water cannot be used and a pump is not desirable, a pressure tank can be used as a high-pressure supply. It should be kept two-thirds full of water, the remaining one-third being air under pressure. Usually, 75 lb. air pressure should be maintained. Where a pressure and gravity tank are used, they are usually on the roof. The connections from each are sometimes brought together in the top story and a main pipe drops down through the building, feeding the sprinklers at each floor.

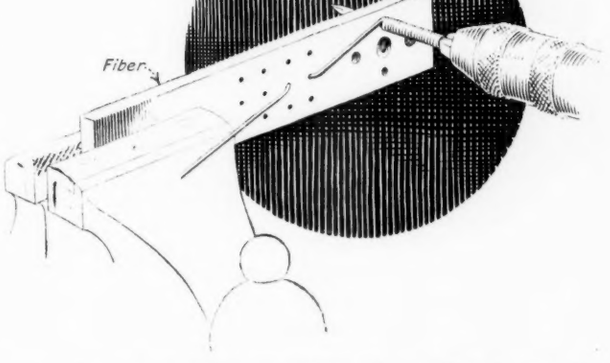
The supplies may vary, but the piping arrangement will be about as described.

(Part two of this article, dealing with supplies, will follow in an early issue.)

Handy Kink for Making Spiral Springs

By J. W. Fager

In making a "spring block" for small springs, I find that ¼-in. fiber works best. Take a piece of fiber about 2 x 6 in. and bore four or five holes in one end, ranging in size from ⅛ to ⅜ in. as in the figure. Near the large holes bore several small ones, say 1/16 in. in diam-



eter. By using nails or pieces of small rod, any size spring can be made, according to the size of the holes.

Put the block in a vise and thread the spring wire through the holes to give it tension. Take a nail the size of the spring you want to make, cut the head off and put it into the hole where it fits best. Wrap a few turns of the wire around the nail and grip the wire and nail in an ordinary brace, as in the figure. Then simply wind the wire around the nail until the desired length of spring is obtained.

Types of Direct-Current Motors—Series, Shunt and Compound

By B. A. BRIGGS

The three general types of direct-current motors, series, shunt and compound, are discussed and some of the important features of each type pointed out. It is shown that a compound motor is a combination of the shunt and series type, and the difference between a cumulative and differential connection is explained.

DIRECT-CURRENT motors may be divided into five general classes according to their electrical characteristics; namely, series, shunt and compound, interpole and compensating types. In all these types the armatures may be the same, the essential difference being in the field-pole windings and the way the latter are connected to the armature. The simplest type is the plain series motor, which derives its name from the fact that the armature and field windings are connected in series. Since the armature and field windings are connected in series, the latter passes all the armature current. Consequently, the wire in the field coils must be large enough to carry the total load current without excessive heating or voltage drop. For this reason the field coils of a series motor are usually wound with a comparatively small number of turns of relatively large-sized wire. The connections of a series motor to an ordinary type of manual starting box are shown in Fig. 1. It will be noticed that there is but one circuit through the starting box, armature and field windings, the armature and field windings being connected in series. Where motors of this type are of 3.5 hp. in size and above, they can generally be determined by inspection, by noting if the machine has only main poles, as in the

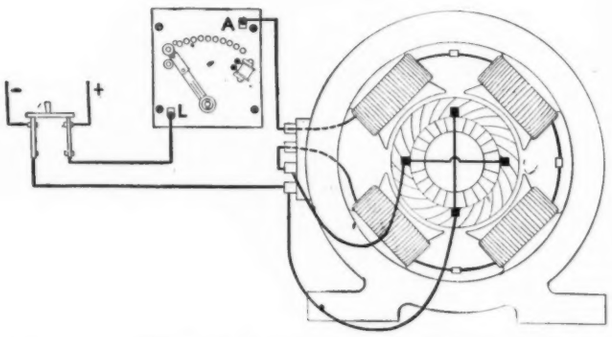


FIG. 1. CONNECTION DIAGRAM FOR SERIES MOTOR AND STARTING BOX

figure, and if the field and armature leads are the same size. A test can be made with a lamp and circuit having machine voltage. If the motor is of the series type, the lamp should light up to full brilliancy when connected across either the field or armature terminals excepting in the case of very small machines.

One of the serious disadvantages of a series motor is that it will race if its load is removed and will destroy itself unless disconnected from the line. If the load is changed on the motor, the speed will vary inversely—that is, if the load is increased the speed will decrease, and if the load is decreased the speed will increase—consequently, the motor is not adapted to constant-speed service. For this reason the motor is used to a very limited extent excepting in cases where it is continuously under the control of an operator; for example, on cranes and railway service. The motor has a characteristic that makes it well adapted to these two classes

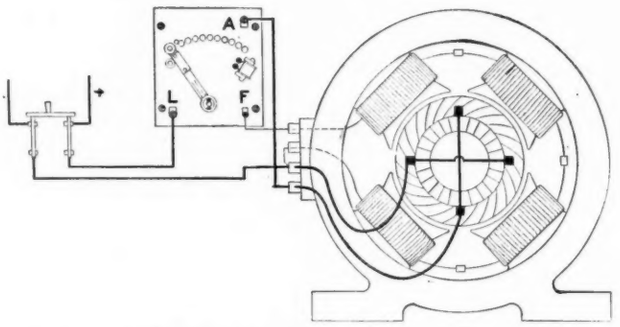


FIG. 2. CONNECTION DIAGRAM FOR SHUNT MOTOR AND STARTING BOX

of service; namely, within certain limits its torque (turning effort) varies as the square of the current; that is, if the current taken from the line is increased by 2, the torque will be increased four times. Why this is so may be readily understood by a consideration of what happens in the motor when the value of the current is doubled in the motor's windings. For example, if the motor takes 10 amperes from the line, this current passes through both the armature and field windings and produces a certain number of lines of force per square inch in the field poles, which is reacted upon by the current passing through the armature conductors and causes the armature to develop a given turning effort. If the current was doubled in the armature, the lines of force remaining constant, the turning effort would be doubled. On the other hand, if the value of the current in the armature was maintained constant and the lines of force doubled in the field pole, the torque would also be doubled. Since the field and armature windings are connected in series, if the current is increased to 20 amperes, then the current will be doubled not only in the armature conductors, but also through the field coil. The latter will increase the lines of force from the field pole by 2. Consequently, when we have two times the current in the armature conductors acting upon two times the flux from the polepieces, this will give four times the turning effort developed by 10 amperes.

Of course this holds true only up to the point where the magnetic circuit begins to approach saturation. Then the increase in torque for an increase in current is not so marked. This characteristic of the torque increasing as the square of the current, makes the motor well adapted to work that requires frequent

starting under heavy loads, as in railway and crane work, and it is in these two applications that the series motor finds its greatest application.

The plain shunt type of motor is in general appearance very much like the series machine, and in the smaller sizes it would be somewhat difficult to distinguish one from the other by a casual inspection. The shunt machine gets its name from having its field coils connected in parallel, or in shunt as it is sometimes called, with the armature. The connections for a simple shunt-type motor and manual-type starting box are shown in Fig. 2. Instead of one circuit, as in the series motor, there are two in the shunt machine; namely, one through the armature and another through the field winding.

The field coils, Fig. 2, are connected directly across the line, therefore, must be wound with a wire of comparatively small cross-section, so that the exciting current will be maintained at a value consistent with high efficiency, and also to prevent the coils from overheating. In this we find the most marked distinction between the series- and the shunt-type machines. In the series machine the field coils are wound with a comparatively small number of turns of large-sized wire, consequently have a low resistance, while in the shunt machine the field coils are wound with a large number of turns of comparatively small wire and have a high resistance. In large-sized machines, 3.5 hp. and up, the motors can be distinguished by the size of the field leads, they being smaller than the armature leads on the shunt machines and the same size on the series machines. In the small machines, where the field and armature leads are the same size on both types, one type may be distinguished from the other by testing through the field coil with a lamp. When tested on the circuit of the machine's rated voltage a lamp connected in series with the field coil of the shunt machine will glow dimly, but on a series machine the lamp will light brightly.

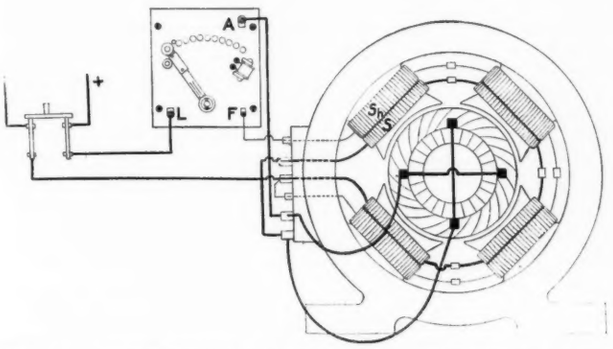


FIG. 3. CONNECTION DIAGRAM FOR COMPOUND MOTOR AND STARTING BOX

Since the field winding of a shunt motor is connected across the line, the magnetic density in the field poles will be practically constant irrespective of the load. Therefore the torque of a shunt motor varies directly as the current in the armature, and not as the square of the current, as in the series machine. In other words, if the current through the armature of a shunt motor is increased by two, the torque is also increased two times. Also, since the strength of the field pole is practically constant, the speed of the motor will be practically constant from no load to full load. In practice the variation is only about 5 to 10 per cent from no load to full load, the speed being higher at no load than at full load. Therefore, in a shunt motor we have a machine the torque of which varies directly as the current in the armature and whose speed is practically constant. These two features make this type of motor applicable to a large number of drives where the starting conditions are not severe and where a constant speed is required over a wide range of load.

There are many drives that require practically a constant speed after the motor has been accelerated and where a strong starting torque is required. In other words, a motor is required that has speed characteristics of a shunt machine and the torque characteristics of a series machine. To meet such requirements, what is known as a compound motor is used, which is nothing more nor less than a shunt machine with the addition of a low-resistance winding on the field pole, connected in series with the armature. The connections for a simple type of compound motor to be started by a manual-type starting box are shown in Fig. 3. It will be seen that the shunt winding, S_h, is connected across the line, the same as in Fig. 2, and the series winding S is connected in series with the armature, as in Fig. 1. The same starting box is used on both the shunt- and compound-wound motors.

Compound Motors for Elevator Service

When compound motors are used on elevator service, the controller is usually arranged so that the series winding is in circuit only while the motor is coming up to speed. After the load has been accelerated, the series winding is cut out of circuit automatically, thus converting the motor into a shunt machine during the running period. In this way the motor is made to act as a generator when the car is traveling in the down motion under heavy load to prevent the machine from racing. Cutting out the series winding during the running period also tends to make the motor run at a more constant speed under variable loads. Although a compound motor will not race as will a series machine under light loads, nevertheless its speed is not as constant under variable loads as a shunt machine. With the average compound motor the speed variations from no load to full load is in the neighborhood of 15 to 20 per cent. This, however, will depend upon the series ampere turns (turns $\times$ amperes) on the polepieces. The greater the number of ampere turns in the series winding the greater will be the starting torque, as also the variation of the motor speed.

There are two ways of connecting compound motors —so that the series and shunt-field windings have the same polarity, and also so that the two windings will have opposite polarities. Where the two sets of field coils are connected so as to have the same polarity, the machine is called a cumulative compound motor; that is, the resultant field strength is the cumulative effect produced by the two windings. When the two windings are so connected that they oppose, the machine is called a differential compound motor, since the resultant field strength is the difference between that produced by the shunt and the series field windings.

The simple series, shunt and compound types, of direct-current motors cover in a general way motors for use on direct-current circuits. There are a number of other types, but they are only modifications of the three types made. These modifications will be made the subjects of other articles.

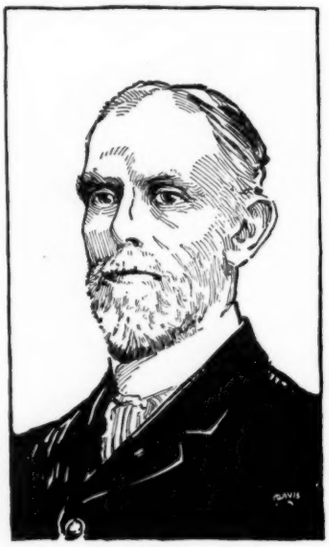
Preliminaries to Cost Accounting in Refrigerating Plants

By PETER NEFF
Consulting Engineer, Canton, Ohio

THERE is probably no other industry in which so much responsibility for success or failure is placed upon the operating engineer as in refrigeration. That this responsibility may be met, the engineer must be alive to his duties, recognize the responsibility and take such steps as will increase his ability to produce a maximum of true efficiency.

The writer believes that the refrigerating industry affords opportunity for development that will make not alone for the good of the plant, but for the character and ability of the engineer, insuring him a career of which he may be proud.

Just a word to the plant owner and manager: When you find your engineer not only giving a full measure of faithful performance of duty, but combining study with experience and thus acquiring true education, and with this development of knowledge gradually improving the plant, give him encouragement and opportunity to broaden his viewpoint. Have him attend association meetings and visit modern plants; see that trade papers are put into his hands; and lastly, do not hold back substantial reward for actual accomplishments. Make him, as his position demands, more than a mere employee. I believe just as deeply in the converse of this, that an engineer who makes no effort to improve himself and the plant under his care, who neglects to study and take advantage of opportunities for improvement, who does not take an interest in knowing what the plant does—for one must first know what a plant is doing before he can compare it with subsequent results—should be relegated to the position of a second, who does simply what he is told, or he should be discharged. The conditions of business now demand that a plant continually improve.



PETER NEFF

Mr. Neff enjoys the distinction of being known to most professional and operating engineers in the refrigerating industry. His life's work has been the upbuilding of this industry. In this article he tells in a direct, pleasingly simple manner what he regards as important to the subject of cost finding in refrigerating plants. The subject is one on which world-wide attention is directed; engineering society committees are now working on it. Mr. Neff does not pretend that the article is scientific or abstruse; it deals with common-sense human and engineering fundamentals which must precede workable cost-accounting systems.

Someone has said that a little learning is a dangerous thing. It is not, unless wrongly applied. It is when a man with the little learning thinks himself fully equipped and then proceeds to apply this knowledge that it is dangerous. The little learning will simply be a stimulus to acquire more, will make him a seeker, will cause him to be cautious in what he undertakes and, lastly, will make him weigh carefully all that he is told and keep him from being carried away by strange and false doctrine.

The engineer must acquire the power to think, to analyze, to combine and coordinate theories with practical conditions as they have to be met. What may be a good thing in one plant may not be the best for another, but for that it is not to be condemned.

Some of us who have been through plant troubles and whose work has brought them for years in contact with various plants and their operation, while not always able to grasp in a brief visit all the conditions surrounding the operation of a particular plant, yet may be able, by discussing the trend of modern practice, to suggest general methods that can be made applicable to a particular case.

It is in that sort of work that help can be rendered to the engineer in charge. It is a process of education. Some have an idea that they must keep their knowledge to themselves. It is a strange thing, but the more one gives of knowledge the more he acquires. The engineer must have his heart in his work. He must be solicitous for the welfare of the plant, which means the success of the business for the owners, make the best of the equipment he has, think about the plant, "read up" on the questions involved, get a thorough understanding of what his plant is doing, and *possess this in a form that will be intelligible to the management.* He should ask for help if there are problems he is in doubt about or on which there is a difference of opinion; make suggestions and discuss them, giving reasons why this or that in his judgment should be done; put himself on record, have arguments for what he proposes; not try to do everything at once, but a little; compare results, and thus have a sure footing for the next step. The refrigerating industry is full of unsolved problems which are being worked upon. He should give his share of experience and knowledge. There is a pleasure that comes from striving and accomplishing, just as there comes with the pleasure a greater remuneration; for when business finds that a man can accomplish more, he will be sought. No education is real if it causes the slightest hint of neglect of one's appointed duties.

If one feels that all the time he should give to the plant under his care is the few hours set aside as so-called working hours, one will never get very far on the road to success.

This industry is growing faster than many realize, and there are offered exceptional opportunities to the man who is ambitious and competent.

I do not propose to give costs, but discuss how the engineer should and can acquire a knowledge of them and what is the basis. When one speaks of costs the subject is likely to be considered as simply dollars and cents. True, it can ultimately be reduced to this basis.

One must get a conception of the principles that underlie all refrigerating processes; these involve a knowledge of heat, the difference between sensible and latent heat, boiling points and how influenced by pressure, effects of superheating gases, transmission of heat from one substance to another. One must be able to visualize what is going on throughout the system.

What the Log Should Tell

A log must be honestly kept and studied; it will serve as a basis for much useful information relative to operation; in fact, it is essential. This log should not be burdensome; every facility should be had to take readings quickly and accurately. Often one finds thermometers placed where they cannot be easily read. There should be fixed thermometers for all important readings —good thermometers with graduations that are plainly visible. Refrigeration being a heat problem at every stage, it is useless to think that useful knowledge can be had without thermometers. Gages are needed; these are often neglected and the engineer does not know whether or not they are correct. In a log the fundamentals to be known are temperature of water to and from the condenser; of the liquid ammonia leaving the condenser and at the feed valve, or for convenience, as it leaves the receiver; of the suction gas as it leaves the evaporator and when it enters the compressor; the discharge leaving the compressor; whatever is cooled, be it brine, air, water, etc. Where brine is circulated for the use of cooling, its outgoing and returning temperature should be recorded, also, if possible, the quantity.

In many cases the medium is first cooled (precooled) by water, as is the case in a distilled-water plant. Here it is necessary to know the temperature of the water available for cooling as well as the temperature to which it is possible to reduce the medium. It is axiomatic that all possible cooling be done by natural means before applying mechanical, illustrated again by distilled water. The apparatus for cooling this with natural water should be such as to reduce it to practically the same temperature as the water available, otherwise there is an unnecessary extra load thrown on the machine. The same applies to the liquid ammonia. Here a large percentage of the work of the machine is used in cooling the ammonia from the temperature of the liquid at the feed valves to the temperature at which ammonia is boiling in the evaporator. Then if it is found that the temperature of the ammonia is higher at the feed valves than when it leaves the condenser, there is something that needs correction. These are emphatically cost problems.

The Graphic Log Worth While

The temperature of the atmosphere must be recorded, also the pressures of the suction and discharge. I will not here touch on the question of power. Every engineer knows that a record of the power used is essential if one would know the costs of production.

There is much to be said in favor of the graphic log, as the eye will detect variations that might otherwise escape; but such a log requires considerable time, though it will repay one to plot them. It is most interesting when one year's run can be compared with another. There is much that could be said about the daily log and what it can be developed into, but we are here simply indicating its necessity for knowing what the plant is doing and making it possible to compare results when changes are made. With the ability to visualize what is taking place in a refrigerating system, one has the groundwork for a cost system.

A refrigerating plant is a manufactury of refrigeration that is disposed of in varying quantities. As there is but one commodity manufactured, everything must be based on some unit of this commodity. If one is making bricks, for example, one may take 1,000 bricks as the unit, and his costs will be so based, as well as the disposition he makes of them. At the end of a given period he will be a poor business man who will not know how many thousand bricks have been made and at what cost, and how many have been disposed of and at what figure per unit. If the number manufactured is considerably more than the amount sold or accounted for, he would be pretty sure to start an investigation. In the refrigerating industry we have been going along from the start with the ton of refrigeration as a standard of measure for the commodity. But we have guessed at the amount we made and guessed at the amount we disposed of. Not only that, but we have been accustomed to buying apparatus for the manufacture of refrigeration with a guarantee for its producing a certain number of tons, and we seldom know if it has fulfilled it. The ice manufacturer may say, "I weigh my ice and know exactly how much refrigeration is produced." The man who meters the brine and can calculate the tonnage disposed of may say he knows exactly his production. It is true they can tell something, but can they tell how many tons of refrigeration they are actually developing to make the ice or cool the brine? It is the same as if the brick manfacturer bought an apparatus to produce so many bricks, no matter if it broke up and made useless a large number besides the required toll of good ones. So in refrigeration, the ice man does not know whether he is developing 1.8 tons refrigeration per ton of ice produced or 2.5 tons.

Engineering Societies Busy on Standards

If we could measure the tons refrigeration we would have a basis for costs and also something that would enable one plant to compare its results with another. Furthermore, it would make the manufacturers more specific with their guarantees. We will see later how this affects them. Owners would be able to compare the working of their plant with that of another, and if one was making a ton of ice with an expenditure of 1.8 tons refrigeration, the other that might be consuming 2.5 would investigate why he suffered such a loss. And the engineer would be the one that he would turn to. We are being driven toward a solution of this problem faster than many imagine. In cold storage it is vital to a proper method of rate making. There is no need of going farther to emphasize the need—all know it is there. What are we going to do about it?

One influence that is making for a solution of the problem is the revision of the power-test codes of the American Society of Mechanical Engineers. The society insists that a method be promulgated for testing refrigerating machinery and has called in a number of engineers to solve the problem. It is perhaps not as

difficult as .. would appear from the time it has taken to get the methods worked out. The delay has been largely because the basic standards for the refrigerant were not accurately determined. But during the last few years considerable work has been done, at least on ammonia, so that we now have fairly accurate data for ammonia; data on other refrigerants are coming.

It is evident that if we know the temperature of the liquid at the feed valves, its specific and latent heat, the pressure and temperature of the evaporated gas, and the number of pounds of the gas evaporated, the amount of refrigeration can be determined. The weight of the liquid evaporated has been the hard task. Such tests as have been made have been by a careful weighing of the liquid on its way to the evaporator.

Through the development of the steam-flow meter there is coming a method of measuring the amount of gas evaporated. When this is accomplished, it will not be difficult to have a record of the volume and weight that a compressor or absorber handles in a given period. Tables can be made that, having the temperature of the liquid, the pressure in the evaporator, the temperature of the evaporated gas to the compressor, the measure of the volume of this gas, the period of time, the tonnage may be quickly calculated or read directly.

[Readers of this article by Mr. Neff will be pleased to learn here that in the new T-Wharf Plant of the Quincy Market Cold Storage & Warehouse Co., Boston, an orifice meter already has been installed for this very purpose—to measure the gas delivered by the compressor to the condenser. Although but recently installed, we learn that it is working satisfactorily in this service. Besides this meter, the plant is provided with venturi meters for water and brine, thermometers and all necessary indicating and recording gages.—Editor.]

This suggests something that will help bridge the gulf between present-day slip-shod methods and the more refined that are to come, something that will serve to educate, while at the same time giving fairly accurate results. It will also avoid the question of expense.

The Compressor as a Flow Meter

The method consists in using the compressor itself as the meter for measuring the amount of gas handled. If the compressor is indicated, the re-expansion loss can be expressed in terms of percentage of stroke, reducing the volume as swept by the piston in its travel. This re-expansion loss is dependent in the same compressor on the relation between the suction and discharge pressures. It is not a difficult matter to determine the loss at some predetermined relation of pressures, as for example 15 and 185 lb., which is commonly used; then by a chart the percentage of variation can be shown for any other combination of pressures. Having determined for an individual compressor the volume available for filling per stroke, it then becomes necessary to know the number of strokes in a given period; this can be found by the use of a revolution counter.

But another element and one not so easily handled is involved—the internal superheating of the gas. Superheating of a gas lessens its weight per cubic foot under a constant pressure. Compressor construction has to do largely with this loss. In p.. ctice the manufacturer allows for it in the size of his compressor when he guarantees a certain effective tonnage. Enough is now known about compressors to predict the loss involved, and there is no reason why the manufacturer should not be forced to produce evidence of what this loss is, for it is a loss in energy expended, and by the use of a flow-meter test this loss is determinable. If the manufacturer will then show what percentage of loss he allows for, due to the superheating of the gas on entering the compressor, one can correct for the difference in density of the gas as delivered in the suction line at the compressor and after it has entered the compressor.

If the volume available for filling is known for a given period and the pressure and temperature of the gas supplied to this volume, corrected for the increase of temperature due to internal superheating, the amount of liquid ammonia evaporated can be found and the tonnage determined. The temperature of the liquid at the feed valves being known, the amount of refrigeration consumed in cooling this to the temperature of the evaporator can be found. This is a loss that has to be borne by the machine, but it can often be considerably lessened if the loss is known and appreciated.

After the gas leaves the evaporator, any increase in temperature before reaching the compressor—in other words, superheating—can also be measured and usually corrected by insulation.

Where Thermometers Are Needed

Naturally, recording instruments are preferable in this work, but by averaging readings from fixed thermometers, as well as for the pressures, a fair degree of accuracy will be had. There is needed to try out this method a thermometer on the suction near the machine, one on liquid line to feed valves, a revolution counter, good gages on the suction and discharge lines, indicator diagrams of the compressor, and correction for internal superheating. Even without specially prepared tables, the data are available in the published tables of properties of the gas used for the refrigerant.

Now such a method, while not scientifically accurate, will help develop a knowledge of one's plant, will serve as a basis for a cost system; will enable the plant to be compared from time to time; and finally will awaken a desire to have and employ more accurate means, such as flow meters. When we do have a measure of the gas handled by a compressor, as will be the case with the flow meters, it will not be long till the variation in internal superheating loss will cause the manufacturers to take steps to make their compressors more efficient in this particular. And it will be a point on which their salesmen will be questioned and one that will be susceptible of verification after the plant is installed.

Basis Necessary in Cost Accounting

Locating preventable losses in plants is one of the prime reasons for a cost system, and we can realize this only by having a basis; while this basis for the time being may not be all that we hope for, it can be corrected from time to time as our knowledge increases.

The ton refrigeration per day, like the kilowatt-hour, may come to mean something, and when spoken of will have a real significance; the fact that it may not be exactly as represented makes little difference if all use it in the same sense.

It would seem to me that the manufacturers of refrigeration apparatus should urge upon such bodies as the American Society of Refrigerating Engineers, that they issue tables and standards that can be used by all, that they be based on the latest available data and that they be arranged conveniently for the use of operating

engineers. Then let the manufacturers assist in the distribution of this information.

In the meantime my suggestion to engineers is to make a start at analyzing plant conditions. Make an attempt to determine the amount of refrigeration that the machine is doing. Get your engineering association to secure the latest tables of data and familiarize yourselves with their use. Start a cost system that will show the amount used of any one thing per ton refrigeration per day. Accustom yourselves to thinking in terms of the ton refrigeration per day. At meetings of associations discuss daily logs in a practical way, the form of sheets which you use and the method employed in getting the quantities that go into the costs as items. There are a lot of these practical problems that should be discussed. A paper on them does little good. It is when you say something and someone argues it with you that you usually get something worth while.

The Ingersoll-Rand P-R Oil Engine

The Ingersoll-Rand Co. is building the Price heavy-oil engine in both horizontal and vertical designs. This engine falls into that class of internal-combustion engines termed solid-injection explosive oil engines, employing a compression of 200 lb. per sq.in. and requiring no ignition surface such as hot bulbs or hot plates. Ignition is by heat of compression only, with the exception that, on starting, an electric coil is employed during the first few explosions.

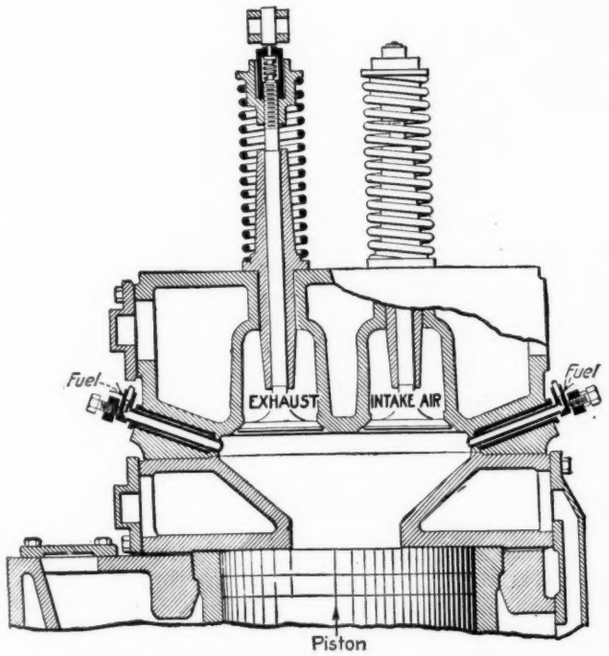


FIG. 1. INGERSOLL-RAND OIL ENGINE CYLINDER HEAD

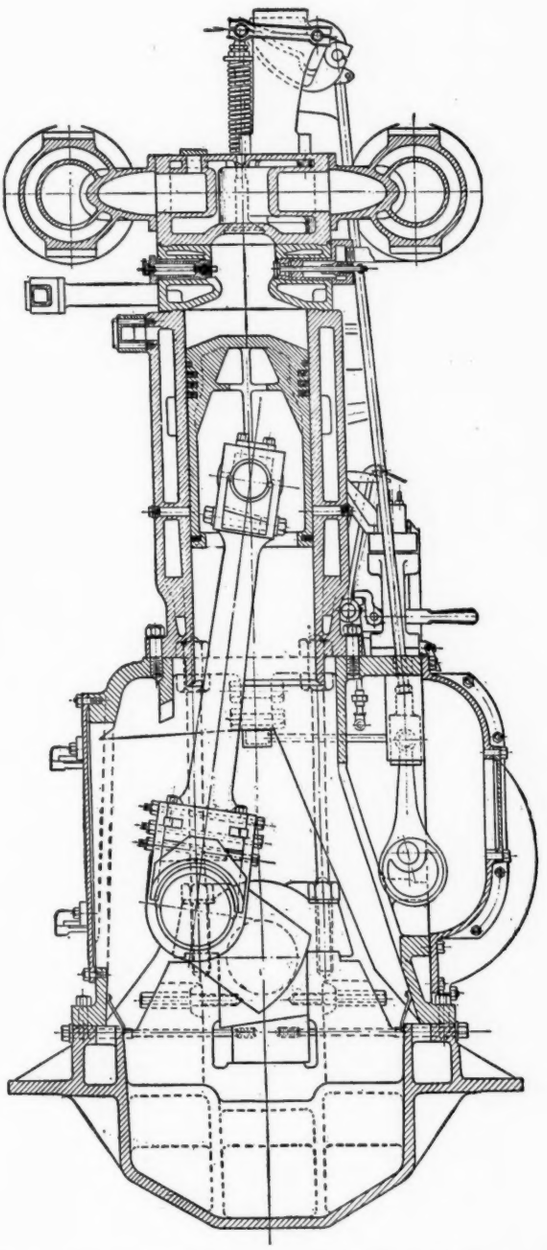


FIG. 2. VERTICAL SECTION OF P-R MARINE OIL ENGINE

The combustion chamber and atomizer are the parts where the design differs from other engines. As the cross-section, Fig. 1, shows, the head is composed of two castings; the lower part acts as the combustion chamber, while the upper casting carries the valves. The lower section, as may be seen from Figs. 1 and 2, has a constricted outlet leading to the cylinder.

The action of the engine is as follows: On the suction stroke the air is drawn into the cylinder and combustion chamber. On the compression stroke the fuel charge is injected through two nozzles, at about 33 deg. ahead of outer dead center, into the combustion chamber. The oil jets issuing from the two nozzles meet at the center of the cavity, creating such a turbulence that a complete mixing of the air and oil is assured. As the piston advances, the pressure and temperature of the cylinder contents increase to an extent that causes the oil to ignite when the piston forces the main air charge into the combustion chamber.

A fuel pump is provided for each working cylinder. The pump plungers are actuated by cams on the camshaft, the governing being accomplished by the opening of a bypass valve on the pump discharge line. In Fig. 3 the pump is immediately to the left of the flywheel.

The marine engine is quite similar to the vertical

stationary engine. The frame is of the inclosed box-section type; the valves are actuated through rockers and push rods by eccentrics on the camshaft. The lubrication of the bearings is accomplished by a combined force feed and splash system. The reversal is rather unique. The timing of the admission and exhaust valves is such that when running ahead one set of valves act as the exhaust, while on going astern the same set of valves are the suction valves and the admission valves now become the exhaust valves. Reversal is accomplished by means of air through a distributor somewhat similar to the starting rig on certain two-cycle hot-bulb oil engines. Since the fuel-pump plunger starts on its outward stroke 35 deg. ahead of dead center and returns at 35 deg. after dead center, it does not require any shifting of the fuel-pump cam to reverse. This is the simplest reversing rig employed on four-cycle oil engines.

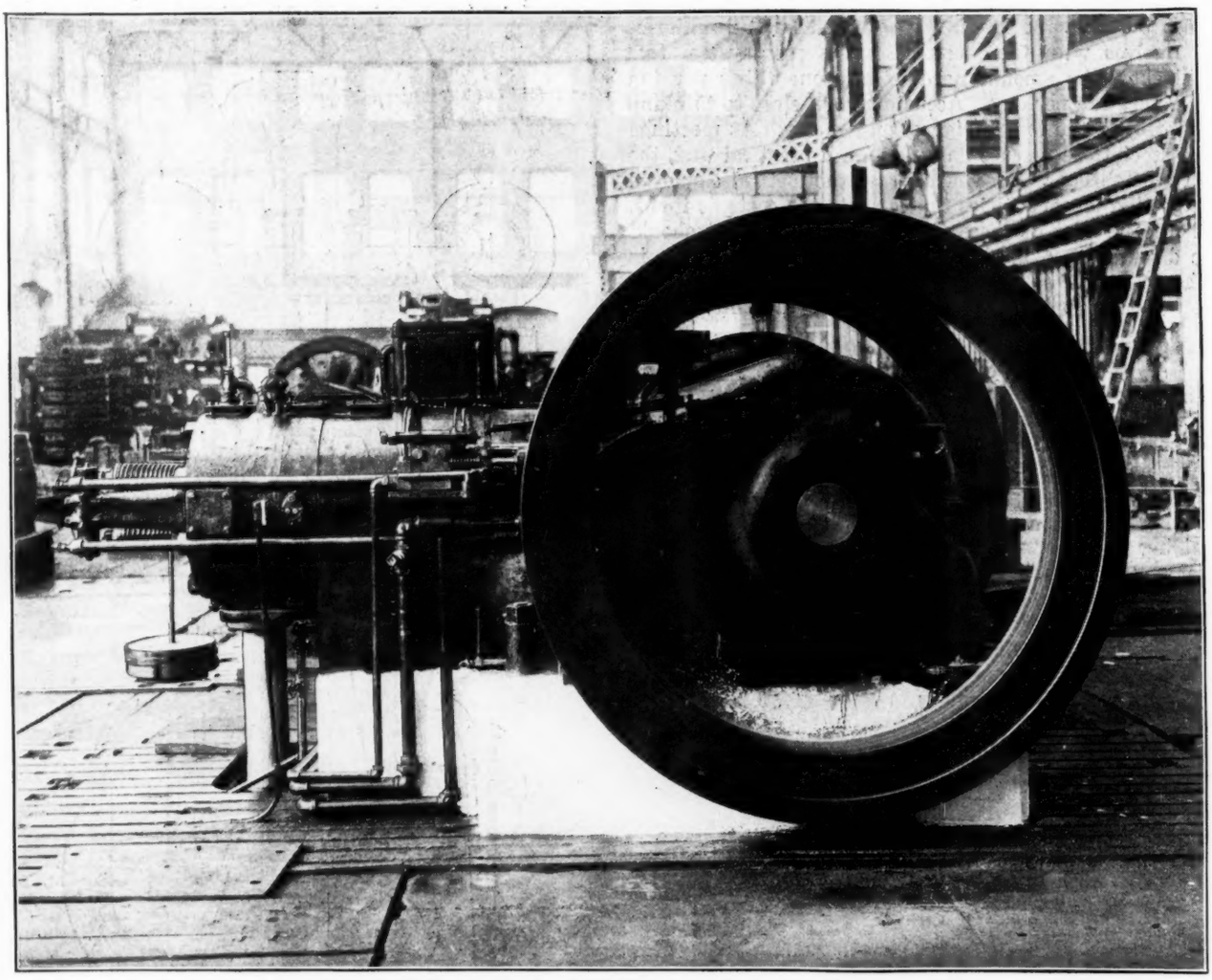


FIG. 3. INGERSOLL-RAND HORIZONTAL OIL ENGINE

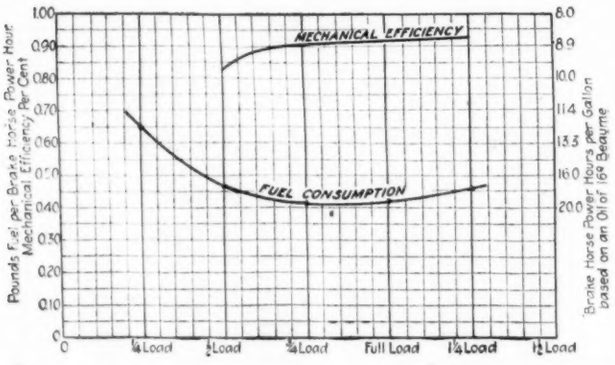
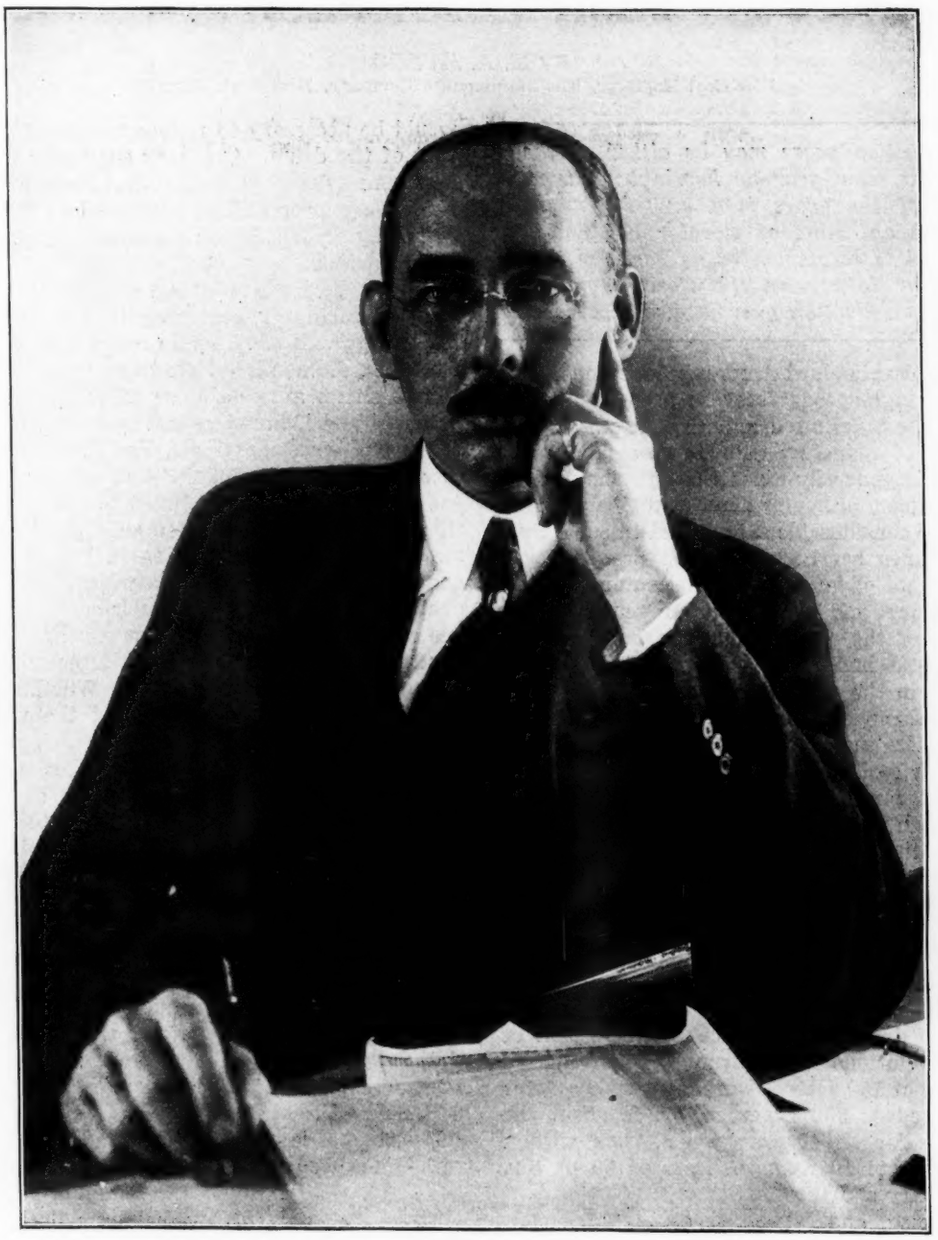


FIG. 4. EFFICIENCY AND FUEL CONSUMPTION CURVES

Fig. 3 is a view of the horizontal P-R engine, which is built in sizes up to 100 hp. The fuel comsumptions for various loads appear in Fig. 4. The thermal efficiency based on indicated horsepower is aproximately 33 per cent at full load; the high mechanical efficiency brings the efficiency based on brake horsepower up to 31 per cent, which is quite excellent even for Diesel engines.

The report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, gives domestic exports of pumps, pumping machinery, refrigerating machinery and air-compressing machinery from the United States by countries for the month of May as valued at $1,964,047. Of these, pumps and pumping machinery come first with a total of $1,155,128, air-compressing machinery second, with a total of $553,808 and refrigerating machinery third, with a total of $255,111.



H. A. Kidder

New Head of the Department of Motive Power, Interborough Rapid Transit Company

H. A. Kidder, formerly electrical superintendent in the motive-power department of the Interborough Rapid Transit Co., and New York Railways Co., of New York, has been appointed assistant superintendent of motive power of both companies. The appointment is made pending final severance of the relations of W. S. Finlay, Jr., with those organizations in the near future, at which time Mr. Kidder will become superintendent of the department.

Mr. Kidder began his career with the companies mentioned as assistant electrical superintendent in 1906, prior to which he was connected with the General Electric Co. in its railway engineering department, and in the following year became electrical superintendent in charge of all electrical operating equipment.

The Interborough Rapid Transit Co. operates all the elevated lines and most of the subway lines in New York City, also most of the surface-car lines. The power department of this company has long been famous, and Mr. Finlay's predecessor, the late Henry G. Stott, attained eminence in his long period of service there. The large reciprocating engine made its last stand in this company's 74th Street Station when Edwin Reynolds, of the Allis-Chalmers Co., designed and installed for this station the Manhattan type engines, each of 7,500 hp. The first of the new type of cross-compound turbines were installed here, of 30,000 kw. capacity, followed by another unit of the same type of 60,000 kw. The reciprocating engine, low pressure turbine units in the company's 59th Street Station were among the first of the kind and are still in service, giving an economy of performance that is perhaps not materially surpassed by any steam prime mover anywhere.

Electric-Elevator Machinery—Worm Gears and Their Lubrication

By M. A. MYERS
Electrical Engineer, The Maintenance Company, New York City.

Elevator reduction gears may be either of the worm-and-gear, spur-gear or herringbone type. Lubrication of the gears is a very important factor in the operation of elevator machinery, and castor oil is recommended as best for this purpose. How to remove the worm from an elevator worm reduction gear is also discussed.

TO DRIVE the standard drum-type elevator, a comparatively high-speed motor is used. Since the speed of the winding drum must necessarily be slow, some type of reduction gear is necessary. This speed reduction is generally made through the medium of a worm and gear, although spur gears have in the past been used to considerable extent, and in some cases in modern machines herringhone gears are employed. In some installations of large-capacity elevator machines a combination worm and gear and spur gear has been used. No parts of the elevator machine have received more attention and had more study devoted to them than those parts in the gear case. These parts consist of a worm and wormwheel, thrust bearings and worm-shaft bearings. In the modern machines these parts are inclosed in a cast-iron case, Fig. 1, which forms part of the elevator machine frame. In Fig. 2 is shown a worm gear, with the top half of the gear case and the cover from the handhole removed to expose the parts. The following problem will indicate the principal reason for the worm-gear speed reduction in elevator machines:

Assume a car travel of 150 ft., at a speed of 150 ft. per min. If the drum is 3 ft. in diameter at the grooves, its circumference will be 9.4 ft. In other words, one revolution of the drum will produce a car motion of 9.4 ft. and 16 revolutions of the drum will be required for the car travel of 150 feet. Using an elevator motor running at a speed of 800 r.p.m., which is about the highest advisable for an elevator worm, then with a reduction from 800 to 16 r.p.m., a ratio of 50 to 1 is the result. Ordinary spur gears are too noisy, and too disposed to vibration, even when inclosed and operating in oil. Neither are they as safe for elevator purposes. Furthermore, the foregoing reduction cannot be made in one step with spur gears, since it would require impracticable gear diameters and impossible frames. In the case cited, for example, if a 3-in. pinion were possible on the motor shaft, a 150-in. gearwheel would be required on the drum shaft, consequently a gear train would be necessary to reduce the speed at the motor to that of the drum. Ordinary spur-gear elevators are to be found even at this date, but most are relics. Herringbone-gear machines and gearless machines are occasionally installed, but these will be the subject of a future article.

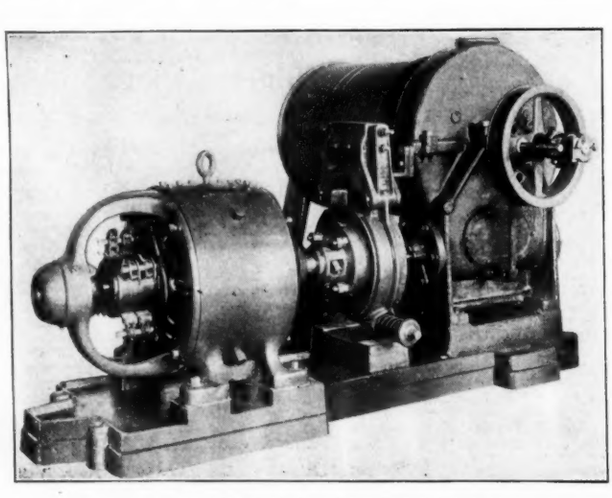


FIG. 1. ELECTRIC ELEVATOR MACHINE

A well designed worm-gear reduction is a reliable piece of machinery, requiring little attention, other than to be kept well oiled. The worm and worm shaft are machined from a solid forging, or at least should be. Fig. 3 shows a worm shaft of a modern elevator machine; *A* and *D* are the shaft bearings; *C* the worm and *B* the ball-thrust bearings. The thrust bearings will be discussed more fully in the next article. Worms are in use that are keyed and pinned to the worm shafts, but this cannot be considered a safe practice. The worm may have a single thread, as in Fig. 3, in which case one revolution will move the wormwheel one tooth; or double thread, known as double-cut worms, which for one revolution moves the wormwheel two teeth. Right-hand cut worms are the rule, although left-hand cut worms are to be found in use. Whether right or left cut, the operation, wear, etc., of the worm gear are practically identical. The worm bearings may or may not be babbitted, as cast iron makes a good bearing material for the steel shaft as long as it is properly oiled. If the bearings are not babbitted, they may be bored out when they wear, and babbitted. Holes *E* and *F*, Fig. 3, are provided to allow the gear oil to reach the shaft easily, and *C* is the stuffing box gland to hold the packing and prevent oil leaking along the worm shaft.

The Hindley (spool) worm and gear, as shown in Fig. 4, differ from the ordinary worm and gear in that the worm is curved to conform with the circumference of the wormwheel. The advantages claimed for this construction are that the worm for its entire length is in complete mesh with the wormwheel teeth; friction and wear are distributed over a greater number of teeth—in other words, the wearing surface is increased; reduction of pressure per square inch of wearing surface between worm and wormwheel teeth, thereby reducing the tendency of lubrication to squeeze out from between the worm and gear teeth; all of which results in a reduction in power loss. The disadvantages are as follows: Difficulty in cutting the worm and gear, requiring special machinery; probable delay in obtaining replacements, and expense of replacements; the necessity of keeping the worm accurately cen-

tered with the wormwheel, which position is usually marked by the manufacturers by prick-punch marks on both worm and gear. Obviously, if the worm moves endwise, the increasing diameter will cause it to bind on the wormwheel in proportion to the movement. A slight wearing of the thrust bearings will allow this end motion, and the friction increase may be very great. If unnoticed at the start, cutting is liable to become so severe as to destroy both worm and gear. To make accurate adjustments for centers, the oil should be removed and the lower gear case handhole opened in order to view the work. The wormwheel, Fig. 6, is of bronze, the teeth being cut in a bronze ring, or rim wheel, provided with a short web and ears for bolting to a cast-iron spider. Fig. 2 shows the assembly, with the handhole cover and the gear-case top removed. Here the method of bolting the rim wheel to the spider is clearly indicated. The nuts on the bolts have setscrews to prevent loosening.

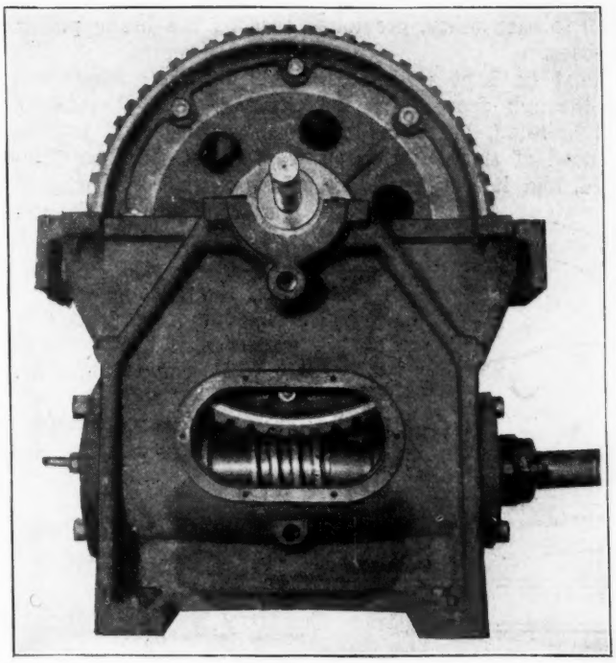


FIG. 2. WORM AND GEAR ASSEMBLED

The factor to be most emphasized in connection with the operation and maintenance of a worm gear is the oil. Because of the high pressure between the worm and wormwheel teeth and in the thrust bearings, an oil of high viscosity and incompressibility (oiliness) should be used—in other words, a lubricant that will not allow itself to be squeezed out from between the rubbing surfaces. The best oil for this purpose is castor oil. A mixture of about 60 to 65 per cent castor oil, with the balance a good grade of cylinder oil, is excellent. The cylinder oil, in addition to reducing the cost of the product, is said to prevent the castor oil from becoming too viscous under certain conditions.

Castor oil has been so difficult or impossible to obtain during the recent strenuous times, that many substitute "gear oils" sprang into existence, giving various degrees of satisfaction. While the castor-oil market is now easier, it is still so expensive that many elevator users will not consider its use. It is the writer's belief, if those who pay the repair and the electric-current bills were brought to realize the saving to be effected in wear and tear on the machinery and in current consumption, a larger number of them would insist upon a fair percentage of castor oil in their elevator gear cases. If the stuffing boxes and bearings are kept in good condition, a good castor-oil mixture will long outlast ordinary oil, not only in lubricating qualities, but in non-leakage qualities, as it will not lose its viscosity on warming up or leak out of the gear case as readily.

The level of oil in the gear case should be kept high enough to completely immerse the worm, but no higher, or oil will be caused to leak out around the drum-shaft bearing. Sufficient oil will be indicated when the spaces between the wormwheel teeth are well lubricated, as they rotate beneath the handhole in the gear-case top. Where thrust bearings are in a housing or bonnet by themselves, oil should be introduced into the bonnet when the machine is first started, after which enough lubricant will usually find its way over from the gear case proper.

Powdered sulphur is sometimes mixed with the gear oil as a polishing agent when the gears are new or when roughened for any reason. If not more than a half pound per gallon of oil is used, it may be left indefinitely, as it will gradually work out of the oil and be deposited at the bottom of the gear case. For more aggravated cases of roughening, a molasses-like mixture of white lead, sulphur and machine oil may be introduced into the gear case. This should be cleaned out after its purpose is accomplished. When possible, it is advisable to operate a new worm-gear reduction unloaded for a period, to

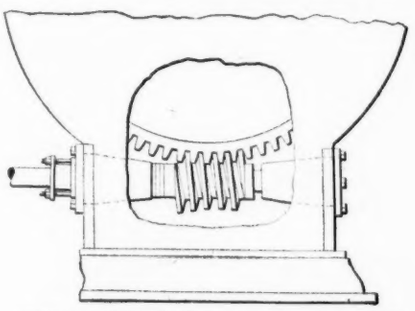


FIG. 4. HINDLEY WORM AND GEAR

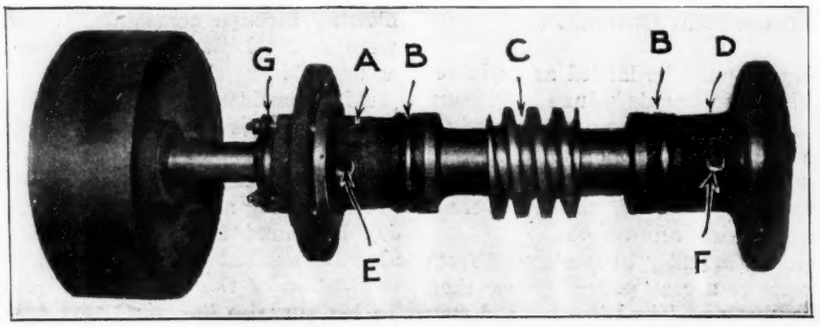


FIG. 3. WORM SHAFT AND BEARINGS

wear the worm and wormwheel to each other, previous to subjecting them to load stresses.

The wormwheel bearings must be kept well oiled. Ordinarily, enough oil leaks through from the gear case to keep these bearings lubricated, but this does not necessarily follow. The speed of this shaft is so low that but little oil is needed, and it is likely to be

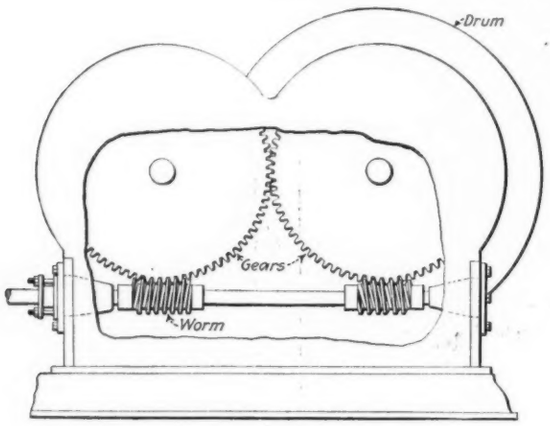


FIG. 5. TANDEM WORM AND GEARS

neglected. It is necessary to keep these bearings and the worm-shaft bearings in particularly good condition, in order to keep the worm and wormwheel in correct mesh. When wear is found, these bearings should be promptly rebabbitted.

When the worm is to be taken out for repairs, it is usually necessary to remove it from the front end of the gear case, as the back end will probably be too close to a wall or other obstruction to remove the shaft that

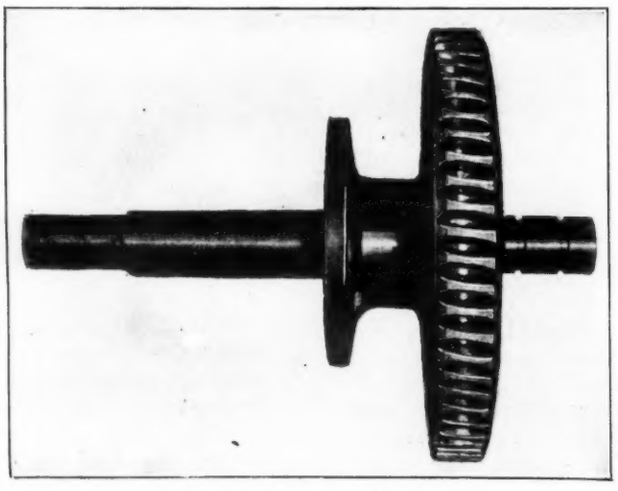


FIG. 6. WORM WHEEL AND SHAFT

way. The counterweights must be landed as explained in the article on "Brake Adjustments," June 29th issue, or the drum blocked, or the car and drum-counterweight cables securely clamped together. The motor is then uncoupled and swung out of the way, after which the brake and brake wheel are removed, the worm-shaft bearing unbolted, and the worm screwed out.

When there is a solid brake pulley to be removed from the shaft, it is advisable to use a "puller" rather than to have recourse to hammering. The latter method may cause alignment troubles or possible distortion of the brake pulley and its attendant difficulties. For identical reasons the brake pulley should be pressed on rather than hammered.

To remove a Hindley (spool) worm which, because of its curvature, obviously cannot be screwed out like an ordinary worm, it is probable that removing both gear-case heads will allow the worm to drop sufficiently to be drawn out. Otherwise it will be necessary to jack up the wormwheel. To remove the worm shaft from a tandem-geared machine, Fig. 5, a similar procedure may be pursued. If dropping the heads does not give sufficient clearance to draw out the worm, it will probably give enough clearance between the worm and the wormwheel teeth to allow the so-called idler gear to be raised up on its companion gear, out of mesh with the worm, thereby allowing the worm shaft to be screwed out. There are cases, however, where both gear wheels must be jacked up to allow removal of the worm.

Improving Power-Plant Operation

By J. C. Moran

Many engineers often make a fuss about economy in some parts of their plant while much larger wastes are allowed to exist in other places. In one case that recently came to my attention, the engineer in a large packing plant died and a new man was hired to take his place.

The former engineer had been a bug on boiler and engine efficiency, and everything around the plant was kept spick and span. To the casual observer the plant was the last word in cleanliness and efficiency. The engines were indicated every week, CO_2 analyses were made once or twice every day, an exact record was kept of the amount of water evaporated and of the amount of coal burned, the firemen were well coached and knew their business, and the boilers were kept in fine condition, both on the inside and the outside. The settings were kept airtight, and the individual dampers on each boiler were adjusted so as to maintain the proper draft pressure for every load.

The plant had four boilers of a total capacity of 600 hp., and the coal consumption averaged about 20 tons per 24 hours when the plant was running at normal capacity. There were four firemen, two on each shift.

Traps a Source of Unsuspected Waste

After the new man had been on the job for a few days, he found that a number of the coils and cooking vats were bled directly to the sewer through a hand-operated valve on the end of the coils or at the outlet from the vats. Generally, the workmen would leave this valve pretty well open and as a result the steam was blowing through constantly, especially when the coils were doing little work and very little condensation accumulated in them.

After considerable argument with the superintendent he finally received permission to buy thermostatic traps for all the coils and vats that were not already provided. These were bought and installed as soon as possible.

While doing some of the work in this connection one day he found that the bypass on one of the traps already installed was wide open. This led to an investigation of the rest of the traps around the plant. To his surprise he found that this condition was the rule instead of the exception with practically all of the traps in the plant.

He got one of the steamfitters to go over every trap in the place and supervised the work himself. There was not a trap in the whole outfit that had a tight valve; in some the floats were collapsed, in others the trunnions on the tilt traps were packed so tight that it was impossible for the trap to move; and in others there was so much lost motion in the operating mechanism that it failed to operate. As a consequence the workmen opened the bypasses and let the steam whistle through, as the simplest method out of the trouble. The condensation in all cases went to the sewer.

While the traps were overhauled and the new ones installed, he connected all the drains to a common return line and connected this to the heater. When all the new traps were installed and the old ones overhauled, they found that the coal consumption had dropped from 20 tons every 24 hours to 17.5 tons. He called the superintendent's attention to this improvement, and the next week he found an extra five-spot in his pay envelope.

Valve and Flange Leaks Stopped

The new engineer did not stop at this. He next turned his attention to the valves around the plant, of which there was a large number. Starting in the boiler room he found that there was hardly a valve in the place that would shut tight; the stems were nearly all in need of packing and were blowing clouds of steam through the stuffing boxes. While going over the valves he also attended to all the leaks in the piping and flange joints and had those covered where the old covering had worn off. In many cases there had never been any covering before, and these pipes were all covered.

He found standard valves on high-pressure lines and cheap valves of the poorest grade on some of the hardest services. Wherever the conditions demanded, he bought the best valves he could get and threw out the old ones. Every valve was gone over, the discs of disc valves were renewed, the gates refitted on gate valves, and seats reground on the globe valves, wherever it was cheaper to repair the old valves than to buy new ones. The stems were repacked on nearly every plant, and every precaution was taken to insure that every valve was tight and would remain so for some time to come. When the job was finished, the coal consumption had dropped to 16 tons.

Pumps a Fruitful Field for Improvement

A large number of pumps were used in the plant for pumping water, oil and lard. The new engineer next turned his attention to these and found them in about the same shape as the steam traps and stop valves. The pumps were in a number of cases located at a distance from the boiler room, and a number of the steam lines were uncovered. The valves in some of the pumps were gone altogether, in others the valve seats were badly worn or scored; the plungers and pistons on the water end were badly in need of packing and in a few instances the steam ends were also in need of new piston rings and refitting of the steam valves, particularly in the simplex pumps with auxiliary valves.

The water-valve seats on all the pumps that required it were reseated with a new machine bought for the purpose. The pistons and plungers were repacked with suitable packing, and the steam ends of those that needed it were sent to a machine shop and refitted. New rods were installed in a number of cases, the old ones being so badly worn that it was impossible to keep them tight. Furthermore, the rods wedged in the stuffing box at each end of the stroke so much in many instances that it almost stopped the pump. Valves with seating rings at the outside circumference and at the center were installed in the power-house pumps and in a number of the others. In the rest new valves of the common disc type were installed, and when the job was finished the coal consumption had dropped to a little over 14 tons.

By means of some more changes in the refrigerating plant, substituting exhaust steam in some cases for processes where live steam had been used before, changes in the motors and lining up of the lineshafts and hoisting gear on the killing floor, the coal consumption was finally cut to a little over 12 tons every 24 hours. At the same time the output of the packing plant was considerably increased over that at the time when the new man first took charge of the plant. In this case the attention to the little things resulted in a saving of approximately $40 per day, or about 40 per cent of the original fuel cost. In addition, in case of necessity the load could be carried on two boilers, and the two firemen on each watch had a "cinch."

In another case the engineer arranged to heat his hot water for the building in the sump, where the condensation and drips from the oil separators, heater and other apparatus were discharged. He utilized the coil from an old closed heater and suspended this in the sump. The hot water for the building was passed through this improvised heater and raised the water temperature from 60 deg. to about 140 deg. and eliminated the necessity of carrying a back pressure on the engines to heat the water for this purpose. This had often to be kept up with live steam during the heating season, because the old water heater was so small that it would not properly do the work at atmospheric pressure, and a back pressure of about five pounds had to be carried both winter and summer. The net result was the saving of nearly a half ton of coal per day during the summer months.

Coal Saved by Overhauling Shafting

In another case a saving of two tons of coal out of a total of 26 per day was made by simply overhauling the lineshafting, adjusting the bearings and putting on heavier belts, that could be run slack and without slipping under the heaviest loads. In another case the simple changing of the belts reduced the coal consumption half a ton per day out of a total of about 10 tons.

In another plant where all but a small lighting unit and a fire pump was shut down over night, a saving of half a ton of coal out of a total of eight every 24 hours was accomplished by a few changes in the piping system so that practically the entire piping system was shut down over night. This eliminated all the condensation losses, leaks through valves and traps and waste from other causes.

In one case a saving of about two tons of coal out of a total of 25 tons per 24 hours was accomplished by installing three friction clutches on an extensive system of lineshafting. The plant was run 24 hours per day, and during a large part of the night the greater proportion of the line shafting was run idle because there was no means to cut it out of service. The friction clutches permitted the various sections of the shafting to be cut out when not in use and eliminated the large friction loss which resulted from the long lines of shafting running idle a large portion of the time.

Pulverized Fuel for Peak-Load Service in Railway Power Plants*

By O. M. Rau

THE Philadelphia Rapid Transit Co. has experienced all the troubles incident to these conditions (burning various coals on the same stokers and grates), as well as the necessity of providing for increased capacity to take care of the growth of its system, which led to a careful study of the problem, and it was found that by purchasing high-load-factor power and generating only peak power, the lowest combined costs would result.

The power costs are approximately 10 per cent of the operating expenses of a traction system, as against 90 per cent for a power company, and therefore are rarely given the careful consideration accorded by the latter.

The combined loads of a traction system and the local electric lighting and power company (less the peaks of the former) will usually increase the economy of the power company's generating system so that the production cost per kilowatt-hour is materially lowered. If this benefit is reflected in the price of power purchased by the traction company, it is apparent that a plant taking care of the traction load only would operate under a disadvantage as compared to a plant carrying the combined loads, and could not produce the power at so low a cost.

With few exceptions power-generating plants operated by traction companies do not produce a kilowatt hour at less than 2¼ lb. of coal, while many of the power plants of the large central stations, particularly when they carry the combined traction and power load of a city, reach a figure as low as 1½ lb. per kilowatt-hour.

Traction Plants as Peak Load Stations

It is therefore apparent that if the power companies will recognize the value of securing a selected block of the transit companies' load, and adjust the rate so that the price of this power is based on actual producion cost, it would be difficult for the traction company to produce this power at its own plants at such cost. This will leave the existing plants of the traction company to be used as peak-load stations, and as stand-by capacity in case of serious interruptions to the power company's system.

This principle has been applied to the generating system of the Philadelphia Rapid Transit Co. and has resulted in a considerable amount of coal being used for banking, in addition to which the necessity for rapidly bringing the boilers up to proper rating suggested a change in firing, and naturally, oil was considered as the proper fuel under these conditions. Investigation soon developed that the cost of oil (with due allowance for its advantages) at the present prices was prohibitive, and resulted in an extensive investigation as to the possibilities of pulverized fuel. This fuel has all the advantages of oil and is not dependent on a selected grade of coal. These qualifications make a particularly attractive fuel under existing operating conditions.

Before the war, when coal contracts on specifications were possible, and selected coal, particularly suited for the furnace equipment was obtainable at a satisfactory price, there was no corresponding advantage to offset the additional cost of pulverizing the coal. This situation has changed. The cost of coal has increased to such an extent that every opportunity to reduce this item of expense must be taken advantage of, and particularly does this apply to the public utilities, which have been unable to add the increased cost of production to their price of service.

The work now in progress by the Philadelphia Rapid Transit Co. consists in equipping its Mt. Vernon power plant, having a rated capacity of 10,000 kw., with a complete milling and burning installation. The plant consists of 20 hand-fired water-tube boilers of 375 hp. each, and five 1,500-kw. d.-c. direct-connected cross-compound engines with two 800-kw. d.-c. exhaust steam turbines. This plant uses anthracite coal to avoid the smoke nuisance. During normal times buckwheat coal such as used by this plant sold for not more than $3 per ton delivered, and while the economy was not equal to that of the large turbine plant, the production cost per kilowatt-hour, taking into account transmission and conversion losses and investment in substation, made the cost of the output from this plant compare favorably with power from any other source.

Pulverized Fuel Adopted

With the increasing cost of material and labor, it soon became apparent that this plant would have to be abandoned or improvements made to reduce operating expenses. The labor cost became excessive, and automatic stokers were contemplated, but with the increasing price of anthracite fuel this improvement was not considered economical, and it became evident that the most efficient use of this plant would be for peak-load service, which means its operation from three to four hours on the morning and evening peak.

Under these conditions of operation the cost of banking fires, as before noted, became of considerable importance, and consideration was given to the use of pulverized fuel, with the result that this method of firing was adopted.

The installation will consist of a six-ton per hour milling plant installed in duplicate to give continuous service; a weighing and conveying system, so that accurate records can be kept of the amount of coal delivered to each boiler; and a furnace equipment consisting of feeders and burners. This equipment is being installed by the Quigley Furnace Specialties Co.

This plant is designed to burn anthracite culm or "river coal." The company controls a supply of 2,000,000 tons, and it will no doubt be the principal supply of fuel for this plant, although other grades or bituminous coal can be utilized equally as efficiently. River coal will be received by rail at one of the storage yards, delivered by trolley to the receiving hopper at the plant, and conveyed to a 100-ton bin over the drier, the latter being of extra large capacity to take care of any excess moisture, although specifications limit this to 8 per cent. From the drier the coal is conveyed to the dry-coal bins above the pulverizers and thence by screw feeds to two high-side Raymond mills capable of reducing three tons of dried coal per hour to a powder having a fineness of 95 per cent through a 150-mesh seive. These mills are of the air-separation type and therefore convey the powder as fast as pulverized to the elevated pulverized-fuel bins, from which the fuel feeds by gravity to the conveying tank. This tank is balanced on a scale and equipped with a compressed-air conveying system, so

*From a paper before the Pennsylvania State Railway Association.

that the pulverized fuel, after being weighed, can be conveyed in any quantity up to the capacity of the tank to the boiler hoppers, of which there is one in front of each boiler, connected with a valve on the conveying line. The fuel, after being weighed, can be delivered to any one of these hoppers.

The feeding and burning equipment consists of two screw feeders attached to the bottom of each boiler hopper. The pulverized fuel falls into the feeder by gravity, controlled by an adjustable gate, and is fed into the burners where it mixes with the required amount of primary air to carry the pulverized coal into the mixing chamber where the necessary auxiliary air for proper combustion is added as the fuel enters the furnace.

Can Use Cheap Coals

This installation will allow the use of any of the cheaper grades of coal or mine refuse from the anthracite districts, or from the soft-coal fields. The labor cost in the boiler room will be considerably below that required for automatic stokers, while the maintenance expense of the burning equipment will be low. It is estimated that furnace maintenance will compare favorably with either hand or stoker firing. The principal items of expense will be in the milling plant. These, however, should be a direct charge to the fuel expense.

The installation of this plant is not yet entirely finished, and therefore no operating data are available at this time. It is estimated, however, that the cost of fuel delivered in the boiler room, including operating expenses, maintenance and fixed charges will not exceed $3.50 per ton, as compared with $5.40, the cost during 1919, which figure would no doubt be considerably higher during 1920.

The saving of fuel during banking periods, according to careful estimates, will amount to not less than 3,000 tons per annum. Experience with boilers fired with pulverized fuel indicates that the heat losses during non-operating period are slight. The steam pressure during a 24-hour shutdown of a boiler fired with pulverized fuel recorded a drop of 5 per cent. This is primarily accounted for by the fact that the furnace can be completely sealed, allowing no air to circulate through the boiler. The total saving to be effected by this installation, it is claimed, will pay for the improvements within two years.

Arca Pressure and Temperature Regulator

A regulator that operates in a different manner from other instruments designed for like purposes is a Swedish invention known as the Arca Regulator, which is being marketed in this country by the American Galco, Inc., Grand Central Palace, New York City.

This regulator depends for its operation upon water under a reasonably constant pressure, between 15 and 90 lb. Unlike most other regulators it operates a globe valve of the usual type by means of a sprocket and chain. The valve is opened in one direction by a piston sliding in a cylinder to which the water is admitted by means of a special piston valve. The valve is closed by a weight when the water is released from the cylinder. Fig. 1 shows the piping and application of the regulator, when used to control the flow of steam and the pressure through a pipe, or a vessel, etc.

A relay *A* is connected to the pipe or vessel in which the pressure is to be kept constant and operates on the slightest variations, and on account of the use of a globe valve and a motive piston of long travel, very smooth operation is obtained.

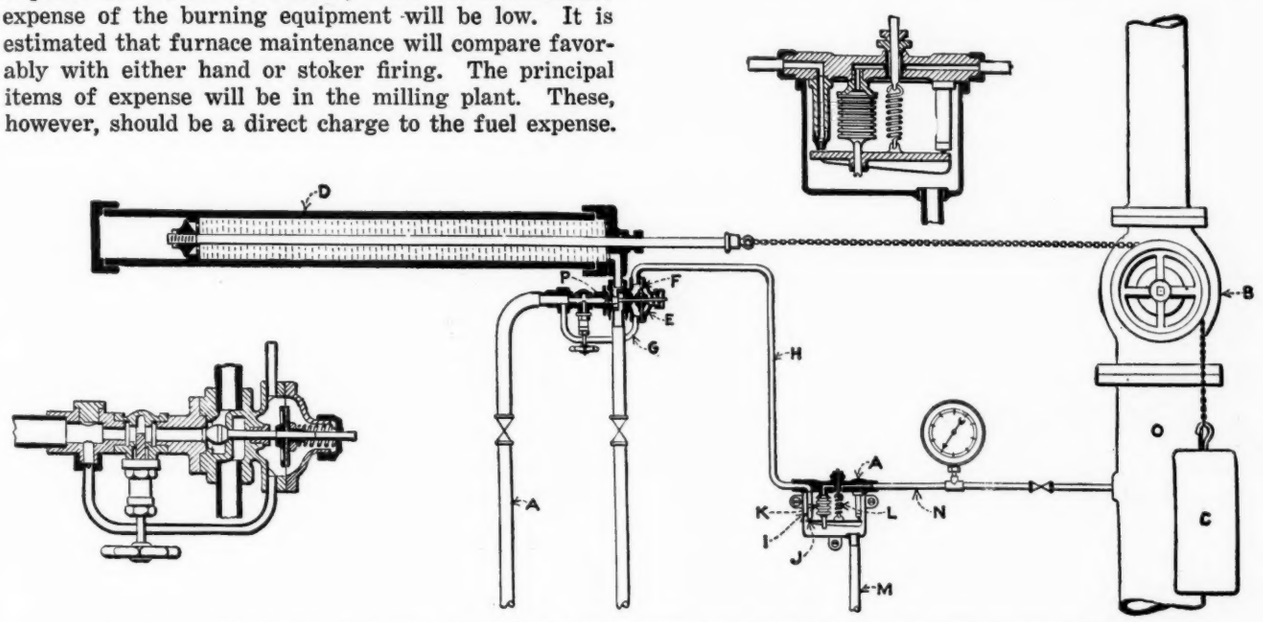


FIG. 1. APPLICATION OF THE ARCA REGULATOR WHEN USED TO CONTROL THE FLOW OF STEAM

The relay, which is the heart, so to speak, of the regulator, is extremely sensitive, and produces close regulation no matter what the fluctuations are on the high-pressure side or the variation in the demand of steam on the low-pressure, or regulated, side.

The globe valve *B* is controlled by a sprocket and a chain supporting a weight at one end. The other end is fastened to a piston operating in the cylinder *D*. Water under at least 15 lb. pressure, moves the piston and sprocket in one direction. When the discharge in the membrane valve *E* is opened, the weight moves the piston in the opposite direction, forcing the water out of the cylinder, and at the same time turns the sprocket of the valve *B*. The valve *E* is moved in one direction by a spring acting on one side of the diaphragm *F* and in the opposite direction by the water under pressure passing through on the other side of the diaphragm.

The water flows through pipe *G*, the diaphragm chamber and the pipe *H*, discharges through the nozzle *I* of the relay. The discharge of the nozzle is controlled by the disk or cup *J*, on a lever that is forced away from the nozzle by the pressure inside a metal bellows *K* or toward the nozzle by a spring *L*. The waste water from the nozzle runs off through pipe *M*. The inside of the metal bellows communicates through the pipe *N* with the low-pressure pipe *O*, where the pressure is to be controlled.

The action of the regulator is as follows: If the pressure should drop in the low-pressure pipe *O*, the spring will move the arm and disk *J*, toward the nozzle *I*, thus reducing the flow of water from the nozzles. This will cause the pressure to build up under the diaphragm *F*, thereby moving the valve piston *P* and admitting water to the cylinder. The cylinder piston will be pushed in or toward the left and the weight will be lifted and at the same time the valve *B* is opened. The movement continues until the pressure is reestablished in the low-pressure system.

In case the pressure in the pipe *O* should rise, the pressure in the bellows *K* will increase and the lever *J* will be forced away from the nozzle *I*. The water will then flow out more freely, causing a pressure drop under the diaphragm *F*. The spring on the diaphragm will therefore move the valve piston *P* and connect the cylinder *D* with the discharge pipe *R*. The weight will immediately drop and move the cylinder piston, forcing the water out of the cylinder and closing the valve *B*. By adjusting the tension of the spring opposing the action of the bellows, the low pressure may be maintained at any point.

Valves are located in the various pipe lines for the purpose of regulating the speed of the action. The regulator is suitable in any case where a reducing valve or regulator is required. Figs. 2 and 3 show steam-pressure regulation charts of paper-machine driers. Fig. 2 shows the variations due to hand regulation.

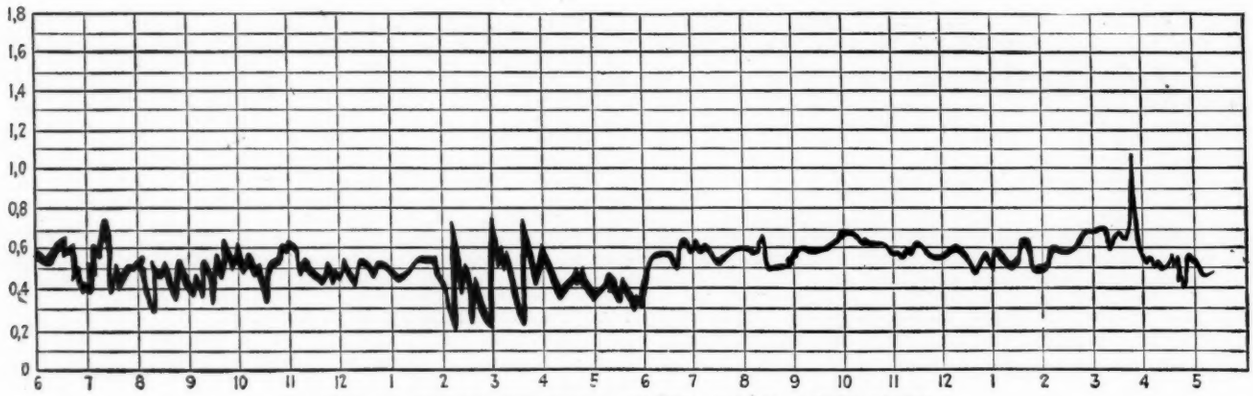


FIG. 2. STEAM-PRESSURE CHART, HAND REGULATION

Fig. 3 was produced with the regulator controlling the steam delivery.

The regulator is also adaptable for controlling the temperature of drying chambers, hot-water tanks, etc., by using a different design of relay from that shown in Fig. 1. This relay, Fig. 4, consists of a nozzle *A* and a glass tube *D* incased in a tube *C*. The connection *E* connects to the space above the diaphragm of the membrane valve *E'*, Fig. 1, and is for discharging whatever water passes through the nozzle *A*. This inclosed tube is so sensitive to changes in temperature that the regulator can be made to operate by merely applying the hand to the tube casing.

Its operation is as follows: With an increase in temperature above a predetermined point the brass is elongated more than the glass rod and this brings the lever *B* nearer to the nozzle seat. This action suppresses the flow of water, building up a higher pressure on the diaphragm in the membrane valve, thereby moving the valve piston and admitting water to the cylinder. The cylinder piston will be pushed in and the weight will be lifted, at the same time partly closing the main valve in the pipe that is supplying steam for the heating.

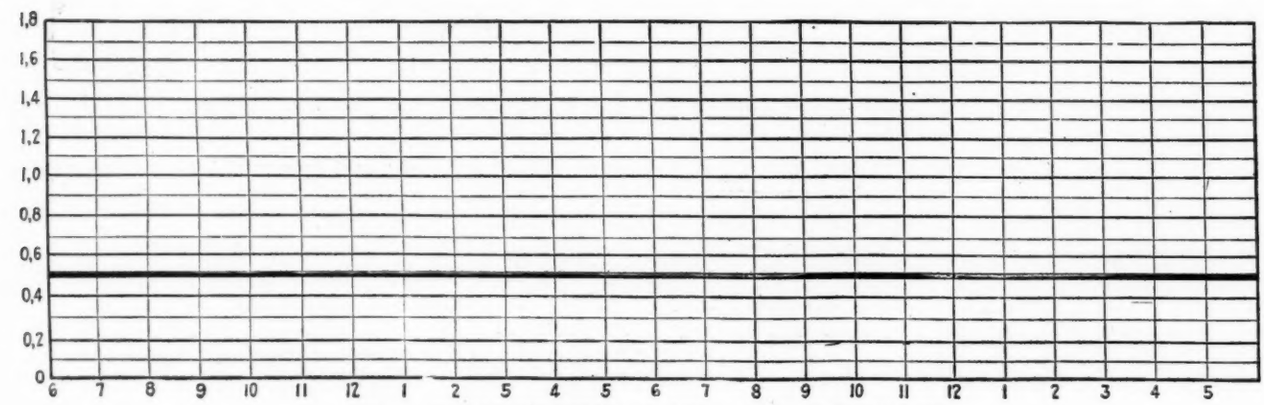


FIG. 3. STEAM-PRESSURE CHART, ARCA REGULATION

When the temperature has become stable, the discharge of water from the nozzle *A*, Fig. 4, is increased and the movement of the cylinder piston plunger is stopped and remains in that position until another change in temperature takes place.

If the temperature drops, the nozzle opening is increased, which reduces the pressure on the diaphragm in the membrane valve and connects the port in the

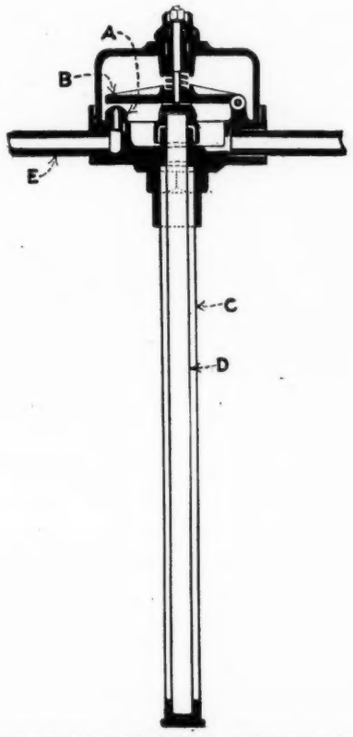


FIG. 4. SECTION THROUGH TEMPERATURE RELAY

cylinder *C* with the water outlet pipe (Fig. 1), letting water out of the cylinder. This action makes it possible for the counterweight to act, pulling out the piston in the cylinder *C*, at the same time opening the valve *B*.

Very low air and gas pressure is controlled in a similar manner, acting on a diaphragm of large area compared with that of the nozzle outlet, thus controlling the discharge of water through it and in so doing regulating the travel of the regulator piston. Thus the air admitted to, say, a boiler furnace could be controlled by either reducing or increasing the speed of the fan.

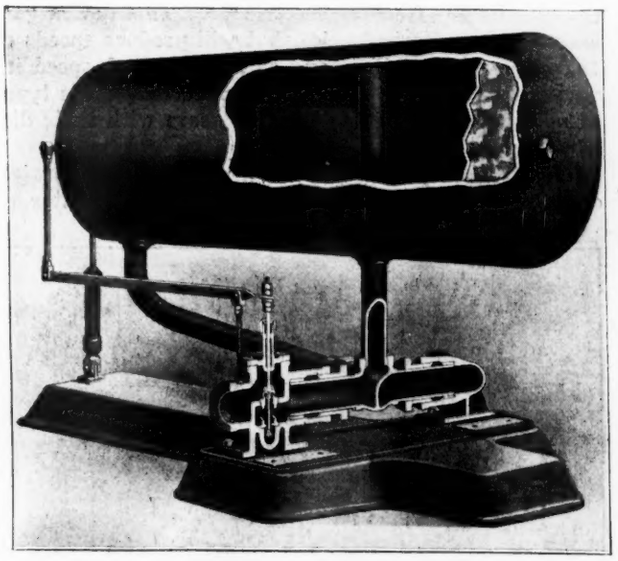
It would seem that this device is suitable for controlling any apparatus that depends upon a difference in either pressure or temperature, as for instance, the speed of a stoker drive, also forced-draft fans, etc., as well as the dampers of hand-fired boilers.

Ellis Tilting Steam Trap

A tilting steam trap of simple design has been perfected by the Ellis Drier Co., of Chicago. It was originally developed for use with the company's grain-drying equipment and proved so satisfactory that it is now being offered for general use as a direct-return, lifting, vacuum or separating trap. The principles of operation are much the same as in other traps of this type. Water of condensation runs into the receiver tank through the trunnion, shown in the accompanying illustration, the tank being in a horizontal position while filling. When sufficient water enters the tank to counterbalance the weight, placed in this case within the tank between a double head, the tank tilts, opening the valve shown, allowing steam to enter the receiver through the vertical pipe and forcing the condensation out of the trap. As soon as the water is discharged, the counterweight brings the tank back to the horizontal position.

A distinguishing feature simplifying the mechanism is the placing of the counterweight within the tank head. This is done at the factory, and as there is neither external lever nor sliding weight, the new arrangement prevents tampering with the adjustment, which might interfere with the proper operation of the tap. It is claimed also that the new location of the counterweight produces rapid tilting action. When the trap begins to tilt, the center of gravity of the counterweight moves forward as it swings through its arc. This shortens the counterweight level arm, which in conjunction with a longer leverage at the other end of the trap accelerates the tilting. With the tank returning to the horizontal position, the opposite action takes place. The center of gravity of the counterweight moves outward, lengthening the lever arm and causing the receiver to swing quickly to place. This rapid action increases to some extent the capacity of the trap.

Other features are a shock absorber consisting of two tempered springs, shown at the left of the illustration



ELLIS TILTING TRAP

and a relief valve attached to and below the steam valve. It is always open when the trap is filling and, as it moves with the steam valve, is closed when the latter is open. The tank is made up of a special iron to resist corrosion. It has welded seams and before shipment is tested under a hydraulic pressure of 450 lb. The ends of the trunnions are faced and turn in removable brass bushings to eliminate binding should the trap get out of level. The trunnion is made of manganese bronze, nickel-plated, so that the glands may be pulled tight and still allow turning with a minimum of friction. The construction is substantial and the operation rapid.

The trap is made in seven sizes for working pressures up to 175 lb. and for capacities ranging from 1,800 to 18,000 lb. of water discharged to the boiler per hour.

Employer's Duty Concerning Boilers

The United States District Court for the Eastern District of Virginia in a recent hearing on a boiler-explosion case, defined the duty of an employer who operates a steam boiler to inspect it regularly and keep it in safe condition. Failure to do this renders him liable for resulting injury to an employee.

The claimant in this case was awarded damages for injury sustained as the result of a tube of a dredge boiler blowing out. The fireman on the dredge had been told by the fireman on the preceding shift that the boiler was leaking. He immediately advised the chief engineer and an investigation was started. The former opened the furnace door to point to the leak, which was at once seen to be a serious one, and an explosion almost instantly occurred, blowing the tube out and seriously scalding the fireman.

The court decided that the employer did not fulfill his duty by merely furnishing a reasonably safe place in which to work, but contended that his duty involved proper inspection and maintenance to the end that the boiler would remain in a reasonably safe condition.

Induction Motors Operating at 18,000 R.P.M.

A new application of the high-speed induction motor to certain classes of machine drive has been made possible by the development of an induction frequency changer by the General Electric Co. This device generates power at frequencies that will produce speeds of 18,000 r.p.m. or higher, and as a result high-speed induction motors can be directly applied to various types of machines, eliminating belts or gears with their disadvantages.

The frequency changer, shown in Fig. 1, consists of a wound-rotor type induction motor, the stator of

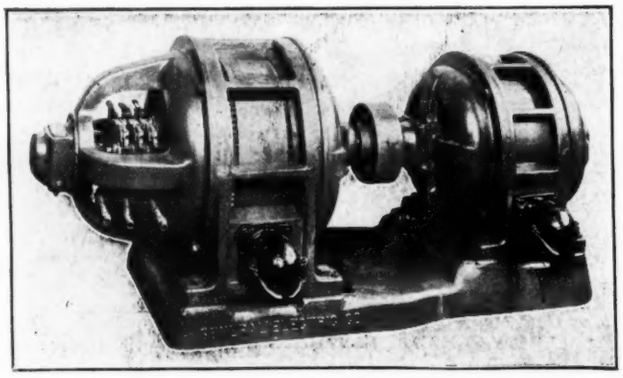


FIG. 1. FREQUENCY-CHANGER SET

which is connected electrically to an alternating-current source of power. By rotating the machine in a direction opposite to that in which it would run as a motor, frequencies are generated in the rotor equal to that of the exciting circuit plus that due to the reversed rotation of the rotor.

Practically all the energy taken from the commercial circuit is transformed into high-frequency energy, the over-all efficiency being approximately 90 per cent. Where direct current only is available, an inverted rotary converter can be used both as a motor to drive the frequency changer and supply the excitation for the stator. The high-frequency supplied by this device being always three-phase secures uniformity as well as economy and simplifies both the motors and the frequency changers. The most economical sets are those having driving motors directly connected to the frequency changers, as in Fig. 1.

The high-speed motors used in connection with these frequency changers are constructed the same as the small standard squirrel-cage motors, having rotors of the cast-alloy type, Fig. 2, and are very compact. In the construction of the rotor the punchings are held securely in place and the slots completely filled with cast

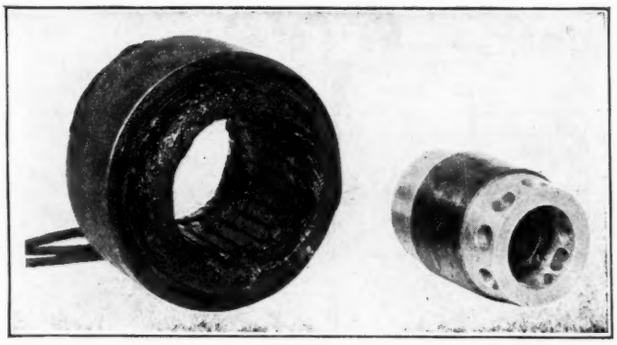


FIG. 2. STATOR AND ROTOR OF 1-HP., 12,000 R.P.M. INDUCTION MOTOR

alloy. In the stator the windings are thoroughly impregnated with moisture-proof insulating compound which acts further to prevent movement of wires and unites the end turns into a solid mass which readily dissipates the heat that is generated in the interior of the winding.

The standard motors are two-pole and wound in two series, the first rated normally at 120 cycles 220 volts, the second at 200 cycles 110 volts, to operate at a range of from 200 to 300 cycles. The operating voltage of the motors must vary in proportion to the speed and frequency, but this change is accomplished automatically by the frequency changer. The normal slip is from 5 to 7 per cent, but where the load is such that the starting torque is the factor in determining the size of the motor, it can be increased by increasing the slip to 8 or 10 per cent, although such changes are objectionable if the motor must carry full load. Successful applications have been made with speeds ranging from 7,200 to 12,000 revolutions per minute.

An investigation of the activities of associations of producers of soft coal in the matter of exchanging reports of prices on sales is being undertaken by the Department of Justice. In connection with this investigation a letter was sent to all secretaries of local associations calling attention to the recent decision of the United States District Court at Memphis, Tenn., condemning the interchange of reports as to prices received on actual sales as practiced by the members of the so-called "Open Competition Plan" of the American Hardwood Manufacturers Association.

The area of grate surface is important, as it is one of the determining factors for proper combustion. The ratio of grate area to the boiler-heating surface will vary from 1 to 35 to 1 to 65, depending on the nature of the fuel and the manner in which it is fired.

EDITORIALS

Coal

IT TOOK the war and its after effects to bring home to the common people the extent to which the civilized world has come to be dependent upon fuel. They have suffered from the scarcity and want of it not so much in actual discomfort from cold in their homes, although this has been near enough to awaken apprehension and to require especial effort and urgency for its avoidance, as from the interruption to their employment, the deprivation of conveniences, the confusion and delay in transportation and the soaring price not only of fuel itself, but of everything into the production and transportation of which fuel enters. The man who, in thinking of fuel, had never got beyond his own cookstove or furnace, has been impressed in a most convincing way of its social-economic importance. It is as though a community, suddenly made conscious of the possibilities and evils of a drought, was just beginning to realize the importance and necessity of organizing its water supply upon a permanent, safe and systematic basis.

The well-being of the people is too intimately dependent upon a cheap and dependable supply of fuel to longer leave its procurement and distribution to the erratic machination of those whose acknowledged aim is to exact profit from rather than to expedite its handling. Any fair-minded person is willing to see the capitalist receive a fair interest on the money that he has actually and necessarily invested, but we are not altogether without sympathy with those who resent the inclusion in their coal bill of interest on the money paid for vast coal tracts to keep them out of the hands of possible competitors and preëmpt them for exploitation in the distant future.

Any fair-minded person wants to see labor involved in mining the coal and in its preparation, transportation and distribution generously requited, and he wants to see the man with the initiative and enterprise and ability to organize and conduct this production and distribution make a fair profit. He knows that the bulk of the discovered coal of the country is in the hands of a combination and that he has to pay for what he needs of it a whole lot more than it costs to mine and transport it. He is not fooled by the statement of kept-lady accountants that most of the coal companies are run at a loss and few make more than a very moderate profit, and he chafes under the impotency of a Government which permits such exploitation of a common resource.

When coal was necessary for the national defense, the Government saw that it was mined, and notwithstanding all the inspired cussing which the Government administration of the railroads got, it distributed the coal (and tons of slate and stuff that was sold at coal prices) at a time when mobilization and mass production were putting a greater stress upon the railroads than ever before.

Nationalization of national resources is looming big on the horizon. If the coal producers are not able and willing to organize their industry so as to produce a dependable supply and get it to the people at necessary cost plus a fair profit, the people will do it themselves. And it is up to the "private ownership" that took on so grievously about the maladministration of the railroads by the Government to demonstrate that it can do at least as well as the Government did under all the stress of unpreparedness and war conditions.

Engineering Articles

THE publication in the July issue of *Mechanical Engineering* of a paper by Messrs. Hampton, Leh and Helmick renews attention to the efforts of the American Society of Mechanical Engineers to encourage the younger engineers to prepare papers on engineering subjects. The society maintains a fund, contributed by one of its members, the income from which is used for prizes to be awarded each year for the best papers on mechanical-engineering subjects by junior members or by student members.

One of the most useful functions of the professional engineering societies is in affording an opportunity for the presentation and discussion of papers dealing with technical affairs. At the same time one of their great problems is to induce engineers to prepare papers measuring up to the standards set by the publication committees. The engineer, especially the one who is most capable of producing the highest-grade article, is often reluctant to put his ideas on paper. If the habit of writing is once acquired, however, it is likely to stick. In offering prizes to student and junior members the society hopes to aid in forming this habit among the younger engineers and so gradually build up a group of men always ready and able to present their ideas and experiences in a simple understandable style to the society and through the society to the engineering public.

Critics of the plan have argued that it would bring out a great mass of papers varying from the only passable to the really worthless. Undoubtedly, this is true. Probably the majority of the material submitted to the committee is poor—much of it very poor. It is also true that there is a great deal of stock, husk and cob grown in order to produce the grain on an ear of corn, but nobody suggests that as a reason against raising corn. It is also true that the stock and husks and even the cobs have some value, and in the same way the poorest of the papers submitted has some worth. The mere action of trying to set down his ideas is good training for the author, if nothing else.

While the prizes referred to can be given only to those connected with the society, there is a field for engineering articles, large or small, "high-brow" or "low-brow," that is open to everybody. That field is the engineering press. It is the great clearing house where ideas are exchanged between engineers, whether they belong to any society or not.

Every man who hopes to succeed must continue to learn more about his business, and one very good way

to learn is to read. Before a thing can be read, however, somebody must write, and in a field as subject to change as modern engineering there is always something new to write about. It is the obvious duty of every engineer whose experience has furnished something new or interesting to write it for the benefit of other engineers. A few misspelled words or a little faulty grammar does not harm. It is the editor's job to look after that. The story, the idea, must come from the engineer, the man out on the job who has met and solved, or tried to solve the problem he writes about. There is money in it for the writer, putting a thing on paper is an education, and the thought of having added something to the general knowledge is a very pleasant sensation.

Try it.

Do Society Elections Foster Indifference?

OUR contemporary, *Engineering and Mining Journal*, in a recent editorial struck a pertinent note when it criticized the procedure of the Harvard Engineering Society in the election of its officers. Although a letter ballot is employed, a single ticket is prepared by the nominating committee and the membership, or at least those who take the trouble, exercise their prerogative of voting by registering approval of the committee's choice.

But why single out the Harvard Society, when the practice is followed also by several of our national engineering societies, including some that acclaim with pride that they are conducted along broad democratic lines?

In refutation it will be pointed out that any member has the option of writing on the ballot his choice for an office, but such scattered votes never mean anything and it is well known that the privilege is seldom exercised.

It is readily conceded that a nominating committee is essential in any large body and that such committees usually make an honest effort to put up a representative ticket. But the principle is wrong. Where a single ticket is nominated, it renders the ballot a farce and is equivalent to the members delegating their proxies to the committee, which might better be termed an election committee and much time and postage saved thereby.

Were the question put up to an open meeting in any of the societies, it is likely the members would insist on at least two candidates for every office regardless of whether there happened to be any issue at stake upon which the candidates represented opposite views.

Complaint is sometimes heard of a prevailing tendency for those in the saddle to commit the membership to various projects and assume that approval will be forthcoming. While it is always necessary that the initiative be taken by a few if progress is to be made, and equally true that a large percentage of the membership usually views the activities with indifference, still it is just such things as the single ticket that foster this indifference.

The strength and influence of a society is not measured by its numbers, but by the interest and activities of its members, and in these days when there is so much said about bringing the engineer to the front, it behooves the societies to use every means to attract and hold the interest of its members individually and collectively.

Send Us Copies of Your Log Sheets

THE high cost of everything that enters into the generation and transmission of power, particularly the prices of coal and the difficulty to get as much as wanted, whatever the grade, make record keeping of power input and output more vital than ever. Of course, writing down the weights of coal and water, the various meter and thermometer readings, the hours this pump and that engine were kept running do little real good if the log sheets are not made use of, if this day's or month's performance is not checked against yesterday's or last month's so that the trend of unit performance may be made known.

We have received many requests for copies of power-plant log sheets, such as daily reports, etc. Our reply to everybody making such request has been that in the first place we did not have any, and secondly, that a log sheet is really of best service when drawn up for the specific plant in which it is to be used. We have not changed our minds about this. But the demand for such sheets seems to warrant publishing a few so drawn up as to include all chief essentials, to apply generally to most plants and, above all, to be in such form as to encourage their use after being filled out.

That we may have the advantage of incorporating all the best features of many logs in the sheets that we hope to publish we are asking that our readers send a copy of each of their forms, that we may study them. These forms should come from all kinds of plants—steam, gas, water, electric and refrigeration. This is a simple, easy way for you to perform a service for your many fellow engineers. We hope for a hearty response to our request.

W. C. Albritton, of Savannah, Ga., is suffering from an attack of perpetuum mobile. It has been five years developing. He has got by the model stage and is undergoing that phase of the malady in which the victim is convinced that his idea will work if it can be tried out upon a large enough scale. The next stage is to unload stock, and its duration and virulence is dependent upon whether the inventor is really the victim of a delusion or just a simple crook. The collapse comes when the idea, if there is really one behind it, is given a fair trial, or when, impatient at his failure to make good, his disappointed stockholders proceed to run the victim out of town.

Elsewhere in this issue, Peter Neff, well-known refrigerating engineer, makes the suggestion that such bodies as the American Society of Refrigerating Engineers issue refrigeration tables and standards that can be used by all, based upon the latest available data. He adds that the manufacturers of refrigerating machinery might assist in the distribution of such literature. It surely would be greatly appreciated by engineers if there was one central source from which they might get such data.

In view of the fuel shortage, good news comes out of Wyoming and Montana. These two states are giving most encouraging yields of petroleum, where production so far is considerably higher per acre of tapped field than in the Mid-Continent and Appalachian regions.

CORRESPONDENCE

Why Not a License Law?

It seems to me that many boiler explosions could be avoided if proper laws were made and enforced. For instance, the laws of New York State, what few there are, are very slack as to the manufacturing and inspecting of steam boilers, and especially so in the qualification of operators. For example, a certain position was vacant that always had been and should have been filled by an engineer who had taken the civil-service examination. A time was set for this examination and at least four tried for it, but before the time for the appointment arrived politics stepped in and a man was appointed that had no practical experience in the engine or boiler room.

I think it the duty of every engineer to insist upon having a strong license law and try to live up to it. As a suggestion, why not appoint three practical experienced men to hold examinations in the largest cities of the state, say once or twice a year, and compel every man who wishes to handle a boiler in any way to obtain a license? Also pass a law making it a criminal offense to hire anyone that has not been examined and passed at least a 75 per cent examination.

Regarding the examination, there are many good operating engineers who are not college educated, and when they come before an examining board, they are unable to write out the simplest parts of their knowledge. Others can put more on paper than they really know. I therefore suggest that a verbal examination be given in connection with a written one.

Some manufacturers build boilers in any old way to carry any old pressure. Some years ago a boiler was desired for a sawmill. The owner went to a boilermaker of good reputation, but his price was too high, and as the purchaser would pay only a certain sum for a certain size of boiler, he was referred to a certain manufacturer who might build him a certain size boiler for a stated sum. This was agreed to and all other specifications were left out. The boiler was delivered and was put in use during the early part of December and was fired steadily until the later part of April, when it was dropped off at intervals of about one day a week during the summer.

In November I chanced to be in the boiler room one morning when there was about 20 lb. of steam. I called the owner's attention to water coming from around the head of a staybolt. He started to calk it, and the tool was driven through the sheet with the first tap. The fire was drawn, and on examination we found about twenty pits nearly through the sheet.

The only reason ever given as to why this boiler deteriorated as it had in eleven months was that soft rainwater was used, and that this had caused the pitting. But I have always thought that the sheets in that boiler were made of mighty poor material.

The Rockport explosion described in the Jan. 6 issue ought to be a lesson to both owner and operator. According to the information contained in the article, there is no doubt that an overpressure caused the accident, but had the safety valve been free to operate, this calamity would doubtless have been averted.

Syracuse, N. Y. M. E. WEBBER.

Water-Test Pressure on Handhole Gaskets

Regarding the answer to the question on "Water-Test Pressure on Handhole Gaskets," I wish to state that I have seen cases where full working pressure was pumped up on the boiler and the gaskets blew out when the boiler was put under steam. That, however, was due to a poorly designed handhole plate. This trouble is more often evident with cast-iron mud drums which do not have a true surface on the inside, and with pressed-steel handhole plates which do not provide wide enough gasket bearing. This trouble is overcome by substituting cast-iron plates with detachable bolts.

One objection to the pressed-steel handhole plates, such as I have used, at least, is that the ledge for the gasket to rest against is rounding and if the gasket makes a start it pushes out. With the cast-iron plates having a square ledge for the gasket to rest against, it can not blow out. E. G. HOPPE.

Cairo, Ill.

Steam-Turbine Has Record Run

In the article "Steam Turbine Has Record Run," page 809 of the May 18 issue of *Power*, it is stated that the machine made a world's record by continuously running 84 days, 11 hours, 36 minutes.

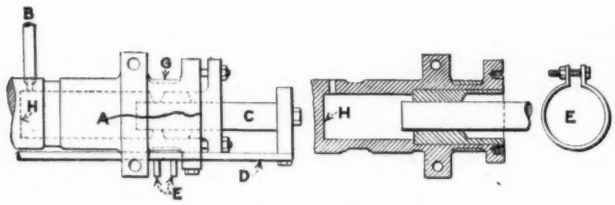
Records on a 1,000-kva. turbine generator at the power plant of the United States Coal and Coke Co., at Gary, W. Va., show that this unit ran 117 days, from June 18, 1919 to October 13, 1919, without a shutdown. During the run the output of the machine was 1,734,700 kw.-hr., or an average of 611 kw. per hour, the load ranging from 200 kw. to 1,300 kw.

The turbine is a single-flow reaction type, running 1,500 r.p.m. and connected to a common bus, serving a mine motor load. It was installed in 1906, and with the exception of two cases of trouble on the generating end and regular periods of inspection and minor repairs it has been in almost continuous service.

Gary, W. Va. E. WOODSON.

Making a Repair to a Cracked Hydraulic Cylinder

A crack about ten inches long developed in the cylinder on a retort press, the construction of which is shown in the illustration. The fluid, under 500 lb. pressure, is admitted through the pipe *B* and pushes the ram *C* outward. There is a similar ram in the other end of the cylinder (not shown), and the two are



CRACKED PORTION OF CYLINDER BUSHED

connected by the member *D*, which carries lugs *E*. The cylinders are separated by the wall *H*.

The fracture is shown at *A*, and in due time it opened up to such an extent that the press was useless. The cylinder was removed, placed in a lathe and enough stock bored out to allow about an inch larger diameter than the stuffing box and deep enough to go to the end of the crack *A*.

A bushing was made, the cylinder heated good and hot and the bushing driven into place. When the cylinder was cool, the bushing was bored to a running fit to the ram and counterbored for the stuffing box.

A groove was then turned around the cylinder as shown at *G*, so as to allow room for a draw band under the member *D*. A draw band was made, shaped as shown at *E*, and, while hot, placed around the cylinder and drawn up as tight as possible.

There was a slight leakage at first on account of there being no material available to make the bushing quite long enough to cover the crack past the end, but it soon took up and the cylinder has been doing service for several months. A new one was ordered, but as long as the old one does at well as it has been doing, it is not likely that it will be put on. P. EARL.

Detroit, Mich.

Cleaning Apparatus for Generator Windings

In the June 1 issue of *Power* F. C. Williams described an apparatus made and used by him for cleaning the windings of motors and generators. I have seen a similar apparatus used around an automobile garage for cleaning parts, and while in charge of a large power plant the chief electrician at my suggestion made and used a similar device. In this particular plant large gas engines were the motive power and salt water was used for cooling the jackets and exhaust manifolds. It was impossible to keep the manifolds tight enough to prevent a small amount of salt vapor from escaping into the engine room, where it was drawn into the generators, and eventually there would be a deposit of salt all through the windings, and it was this deposit that the device was used to remove.

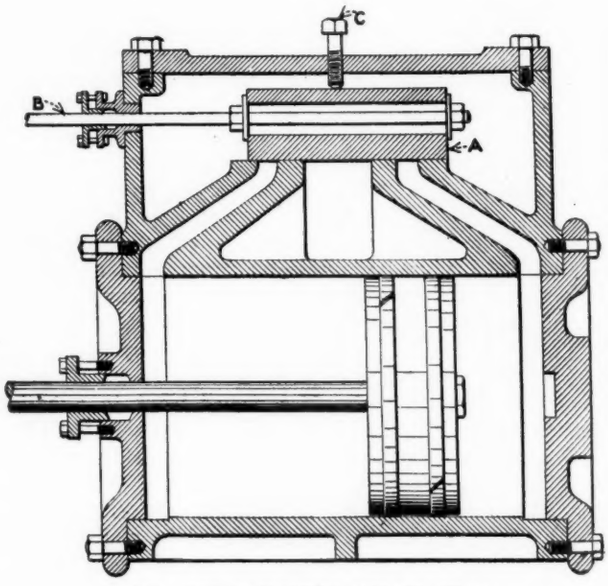
One machine had been cleaned successfully, and the electricians, three of them, were working on the second. They had it well soaked up and the work was progressing nicely when there was a loud roar and that generator and two of the men were a mass of flames, which resulted in three or four men being very seriously burned, and one probably crippled for life. The fire in the generator could not be extinguished until the gasoline had mostly burned out of the windings, and only the fact that the machine was bar-wound and mica-insulated saved it from being ruined. This should serve as a warning to anyone that contemplates the use of a device of this description to be sure that there is no open flame at any place in the building, before turning it on. The vapor thrown is almost as explosive as powder and it only needs a spark to set it off.

In this particular case there was, away over in the corner of the plant, an innocent little gas flame that every one had forgotten, used to keep an oil tank warm, but it got in its deadly work and the great wonder is that there was not loss of life and property. This is not meant to criticize Mr. Williams' device. It is efficient and will do the work, but every precaution should be used in regard to open lights or sparks in the same room. EARL PAGETT.

Cherryville, Kan.

Refacing a Slide-Valve Seat

A method of refacing the seat on which an ordinary slide valve operates is to make a steel block *A* the size of the valve and drill a hole through it in which to fit the valve stem *B*. One side of this block is cut like a file. It is then tempered and fitted to the rod *B*. Then



RIG FOR REFACING VALVE SEAT

fit lengthwise across the steam chest another iron plate 2 in. wide and ½ in. thick, having a screw hole in which to insert the screw bolt *C*. This plate is held in place by means of the steam-chest cover studs and nuts.

With everything in place and a slight pressure exerted on the plate *A* by the screw *C*, move the plate *A* back and forth by means of the rod *B* until the seat is true. HAARBAND SINGH.

Lahore, India.

Trouble with a Loose Piston Head

An engineer located a pound in the high-pressure cylinder and upon examination found that the piston had worked loose on the rod, the piston having been forced on a taper, leaving a clearance between the face of the piston and the nut, as shown at *A*, Fig. 1. A

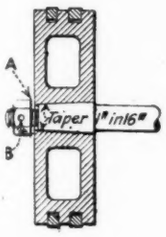


Fig. 1.

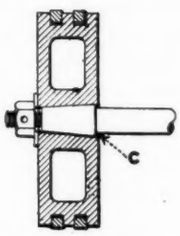


Fig. 2.

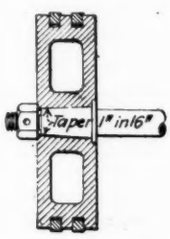


Fig. 3.

FIGS. 1 and 2. CONDITION OF OLD PISTON ROD. FIG. 3. A SUGGESTED IMPROVEMENT

washer was inserted between the face of the piston and the nut; the latter was then secured in place with a pin *B*.

All went well for a short time, and then the pounding suddenly developed again. An examination showed the piston had been forced onto the taper of the rod until the face of the piston overhung the end of the taper, as shown at *C*, Fig. 2. The situation was now serious, due to the close piston clearances. The makers were consulted, and they suggested that the cause was due to water in the cylinder. The piston was sent to the works, and after an examination it was decided to rebore it to a taper of 1 in. in 8 in. (the original taper being 1 in. in 16 in.) and to fit in a new piston rod. The piston was to be heated in a steam oven that was subjected to a pressure of 240 lb. per sq.in. and to be put on the rod in this heated condition and the nut screwed home. This was done, and after the piston had cooled down the nut was again tested for tightness and secured with a pin.

The engine has been in operation for some time and no further bother has been had with a loose piston.

The questions that arise are: Was the taper of 1 in. in 8 in. correct for this design of piston, seeing that the piston-rod taper has no shoulder for the head to press against? Was any material advantage gained by steam heating the piston head? Would it not have been better to have formed a shoulder at the end of the taper of the new piston rod to rest against, recessing the piston to suit, as shown as *D*, Fig. 3, leaving the bores, 1 in. in 16 in., intact? THOMAS W. AIREY.

Gainsborough, England.

Growth of Internal-Combustion Engine Horsepower

We read with considerable interest an article by Prof. L. W. W. Morrow in the June 8 issue, entitled "A Study of Power Development and Suggestions for Future Progress." We are inclined to believe, however, that the data presented in Fig. 3 referring to internal-combustion engines is not correct.

We do not know, of course, what sources of information the author had in preparing this chart, but according to it from the year 1913 to 1920 the horsepower of internal-combustion engines increased approximately 300,000, or an average of 45,000 hp. per year. This figure is certainly too small, as in one industry alone—the extraction of gasoline from natural gas by the compression process—more than this total horsepower is being added yearly.

There are other fields, such as blast-furnace operation, where large units are being added from time to time. For example, the Lackawanna Steel Co. has completed the installation of five Mesta gas blowing engines which alone would account for nearly half of the total horsepower allowed by Professor Morrow.

ALWIN SCHALLER, Gen. Mgr.,
Wellsville, N. Y. McEwen Bros.

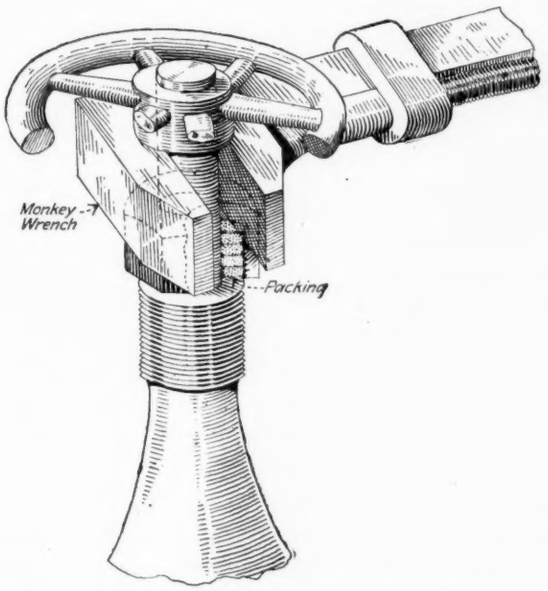
The information regarding the horsepower of internal-combustion engines installed was obtained from the United States Census of Manufactures, 1914-17, and current journals to October of last year, and therefore did not consider the installation mentioned. There is no question of the desirability of blast-furnace engine installations, and a large increase is to be expected in this industry. L. W. W. MORROW.

New Haven, Conn.

Valve-Stem Packing Kink

When packing a gate or a globe valve, using a packing nut that screws onto the neck of the valve bonnet, it is sometimes difficult to start the nut on, if it is well filled with packing. Of course this difficulty may be avoided by not filling the nut too full, but I prefer to stuff a goodly amount of packing into the nut so as to repack less frequently.

This difficulty may be avoided by opening an ordinary monkey wrench a little wider than the diameter of the valve stem, and placing it over the stem between the valve wheel and the packing nut, as shown. If the valve wheel is then turned until the nut is brought up



SCREWING ON A PACKING NUT

to the threads on the valve bonnet, and the nut is turned at the same time, it will start on easily and there is plenty of packing around the stem.

In case the distance between the nut and the valve wheel is too great to permit the use of a monkey wrench, a piece of wood of the proper thickness may be used.

Arlington, Mass. JOHN D. EBERHARDT.

Industrial and Central-Station Plants

The article by Cornelius G. Weber, on "Interconnecting Industrial and Central-Station Plants," page 1049 of the June 29 issue of *Power*, as well as several recent articles on similar subjects, shows a growing tendency to recognize the value of the isolated plant to the community at large.

We have read during the last few years of the wonderful strides made by the modern central station in reducing its unit output cost in spite of the increased cost of coal, labor, supplies, etc. If we look at the reason for this, we find brilliant engineers who make this their life work; in fact, some large central station will usually bid quite high for the services of this type of engineer. Then, too, through the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, these same men keep in touch with one another, exchange ideas and publish records of their experiments for the benefit of all.

The poor isolated plants have no such interest shown them. Anyone, be he architect, consulting engineer or otherwise, is allowed to buy the apparatus and assemble it under one roof and call it a power plant. Perhaps it is; but ask the man who operates it what he thinks. Very likely the individual boilers, engines and pumps are the best in the market, but they do not fit together on the basis of over-all plant efficiency. And sometimes, where the plant itself is all right as far as the different apparatus working economically together is concerned, the plant as a whole does not fit the industrial factory for which it was built.

These facts are not new by any means, and only the economic necessity caused by the high cost of everything makes them a factor to be considered. The operating engineer has been preached to about "economy" in the plant. He should keep his boilers clean, inside and out, heat the feed water, indicate the engines, etc., which is all good advice; but when a plant is designed all wrong to start with, and no matter how hard the engineer works, he can attain only a half to three-quarters of the economy and efficiency he should —well, he is very likely to lose some of his enthusiasm and just keep the plant going and no more. This, it may be said, should not be the attitude of the engineer, but it is in many instances.

No right-thinking individual denies the fact that it is a good thing to have an engineers' license law to protect the rest of the community from the ignorant and careless handling of boilers and other power-plant apparatus by incompetent help. In fact, it is now advocated by certain engineers that the engineers' license law should also cover economy in plant operation, making it compulsory for every engineer to at least know the principles of economical power-plant operation, even if he does not practice them.

But going a step farther, it seems that it would be even more desirable to do something toward preventing the construction of poorly designed plants. Power plants that could not be made to attain the ordinary economy, no matter how operated, should never be built. Why not license the power-plant designers, or at least have their designs passed upon by a board of competent engineers, similar to the method that is used in getting building plans approved in large cities? This would institute several benefits: It would make the plant owner realize more clearly the importance of his own power plant, and incidentally raise his opinion of his engineering employees and probably their wages; the plant designer would have an increased incentive to see that the operating engineer was not only competent at the start, but kept his plant in shape at all times; and following the natural law of supply and demand, the higher wages would attract a more intelligent class of workers, to everyone's advantage.

Interconnecting the small isolated plants with the central station would take a large load off the minds of the isolated-plant engineers and has so many economic advantages that a fair-sized book could be written about it. But why is it not done? The answer is simply that the central stations will not hear of it. They are looking for all the business or nothing. Unless the Government steps in and forces this matter, it will probably never take place. There are many buildings so situated that, from their own isolated plant, they could supply light, heat and power to their neighbors, but this is blocked as a rule by local ordinances forbidding the running of steam pipe or electric conduit through building walls or across streets.

It would seem that the block plant, supplying light, heat and power to all the buildings in the block, or possibly in the vicinity, would be an ideal scheme if interconnected with the local central station; and its size would be such that competent help could be hired, to the mutual benefit of all concerned.

That the small isolated plant is doomed in the future, there is no doubt, but certainly the central station does not offer the best solution, when the steam requirements for heating and manufacturing purposes are taken into consideration.

The proposed plan of the Government to interconnect the various central stations and build new ones at the mines is a step in the right direction, but it hits only the high spots and does not take care of the small manufacturer, who needs steam served with his electricity.

WARREN D. LEWIS.

New York City.

Water-Column Connections

In a battery of boilers of which I have charge, the connections of the water columns are different. Some have the steam connection in the front head and others are connected at the top of the shell; some have the water connection at the bottom of the front head, and one has the connection near the top of the tubes, being placed there, no doubt, after careful calculations as to the weight of water at different temperatures and the weight of mixtures of steam and water.

The worst performer of the bunch was the one that had the connection nearest the top of the tubes. It was a high jumper—not merely one to three inches low, as Mr. Orr in a recent issue calculates it ought to be for the near-the-bottom connection, but six inches and more above the true level.

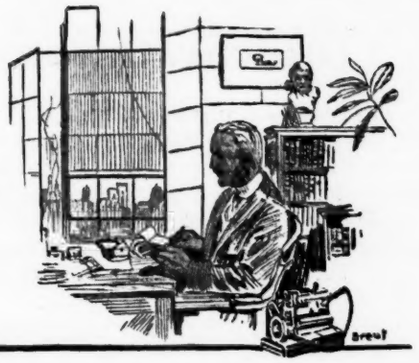
Many guesses were made as to the cause of its performance, and I made a few myself, my last being that it was due to the fact that the pipe forming the lower connection was exposed to the hot gases in the smoke box. Acting on this, we covered the pipe with insulating material and proved that the last guess was the correct one.

The steam formed in the pipe was carrying the water up into the water column, where there was room for separation to take place.

R. MCLAREN.

Toronto, Ont., Canada.

INQUIRIES OF GENERAL INTEREST



Testing for Water and Dirt in Fuel Oil—What is a good method of determining the amount of water and dirt in fuel oil? W. T.

Mix a small quantity of the oil in a glass test tube with an equal quantity of gasoline and allow the mixture to stand in a warm place for 24 hours, when the dirt and water will settle to the bottom.

Blowdown of Safety Valve—Why does a safety valve remain open after the boiler pressure has dropped below the pressure at which the valve is set? W. E. G.

The valve remains open because the form of the valve is such that when it is raised from its seat the area of the valve that is acted upon by the escaping steam is greater than the area presented to pressure of the steam within the boiler when the valve is closed.

Protection of Steel Smoke Flue from Rusting—We have considerable trouble from interior rusting of sheet-steel smoke flues that connect boiler uptakes with the chimney. How can the corrosion be prevented? W. B. R.

The best protective covering for the purpose is a wash of portland cement and water mixed to a consistency of cold-water paint and applied with a stiff brush after the surfaces to be covered have been thoroughly scraped and cleaned.

Increasing Cushion on Duplex Pump—How can the amount of cushioning be increased on a duplex pump that is not provided with cushion-regulating valves? A. R. D.

The exhaust can be closed earlier, and thereby provide for a longer cushion, by turning off the diameter of the piston sufficiently to allow for a piston ring with an offset overlapping the piston. In this way a piston ring can be used that will be as wide as the piston, and a cushion can be obtained as long as the piston will permit.

Water Rate of Engine—What is meant by an engine running on 12 lb. of water per horsepower-hour? J. E.

The statement is intended to signify that the weight of steam consumed is 12 lb. per horsepower-hour, which would be the weight of steam generated from 12 lb. of water or the "water-rate." A statement of water rate is incomplete in expressing economy of a steam engine unless also the pressure and quality of steam supplied and the back pressure on the exhaust are specified or understood.

Material of Clean Tubes Unaffected by Forcing Boiler—What is the highest rate of transfer of heat that can be made through water tubes of a boiler without destroying the material? J. A. G.

The highest rate of heat transfer has never been known to destroy the metal when the tubes have been clean and kept covered with water. The rate required to burn out the tubes depends on the circulation and the kind and quantity of scale or other coating on the water side of the tubes. When new tubes have been burned out after very short use, the trouble has been traced to presence of oil.

Width for Machine Belt—What width of single leather belt would be suitable for transmission of 3¼ hp. to a machine that is provided with an iron receiving pulley 12 in. in diameter, to run 275 r.p.m.? W. L. F.

Each inch of good-quality single leather belt running on an iron pulley 30 in. in diameter and making 100 r.p.m., or 785 ft. per min., may be depended upon for transmission of 1 hp., and for the same stress of belt per inch of width, transmission of 3¼ hp. to a 12-in. pulley running 275 r.p.m. would require a belt width of

$$\frac{100 \times 30}{275 \times 12} \times 3\tfrac{1}{4} = 2.9, \text{ or practically 3 inches.}$$

Testing with Air Pressure—Is air pressure as reliable as hydrostatic pressure for testing the tightness of piping, boilers or other pressure containers? H. T.

When the test pressure can be held, testing with air pressure is fully as reliable an indication of strength and tightness as testing by hydrostatic pressure. Original testing by air pressure alone is dangerous, for in event of rupture of the pipe or vessel under test, the rapid expansion and high velocity of the escaping air and recoil of the vessel may have the effect of a destructive explosion. For the same reasons serious damage has frequently resulted in making hydrostatic tests of vessels that were partly filled with air. Tests of strength should first be made with hydrostatic pressure 50 per cent in excess of the allowable working pressure. As air is more searching of leaks, the joints of piping and containers for compressed air or gases may be more thoroughly tested by air pressure, but in cases where it is desirable to insure against an explosive effect, testing by air pressure should be preceded by a higher hydrostatic pressure.

Causes of Failure of Injector—What may be the cause of failure in operation of an injector? The tubes and parts are clean and show very little wear. W. H. A.

The trouble may be due to a leaky suction pipe. Plug the ends of the suction and overflow pipes. Then turn on the steam supply and the location of any leaks will be indicated by an escape of steam. The injector may be too hot to start, due to a leaking steam valve, or the feed water may be too hot. The suction pipe or strainer may be obstructed. Such obstructions usually can be removed by turning on steam after blocking the overflow and closing the delivery to the boiler. The delivery pipe may be choked or the check-valve may be faulty, either of which would be indicated by discharge at the overflow or inability to maintain the usual water level in the boiler. To test for these defects, place an accurate pressure gage on the delivery side of the injector and note whether it indicates pressure in excess of the boiler pressure. It may be that the steam supply pipe is choked or that the injector is supplied by wet steam, caused by foaming or priming of the boiler. The steam supplied should be taken from an independent connection out of the highest part of the boiler to insure dryness. On the other hand, superheated steam will not usually give results as satisfactory as dry saturated steam, as sufficient time may not be permitted for its condensation in the injector.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A. S. M. E. Boiler Code

The following answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee and approved by the Council of the American Society of Mechanical Engineers. The formal inquiry and reply are given together with explanatory references to the Code and illustrations where necessary for a better understanding of the interpretations as issued.

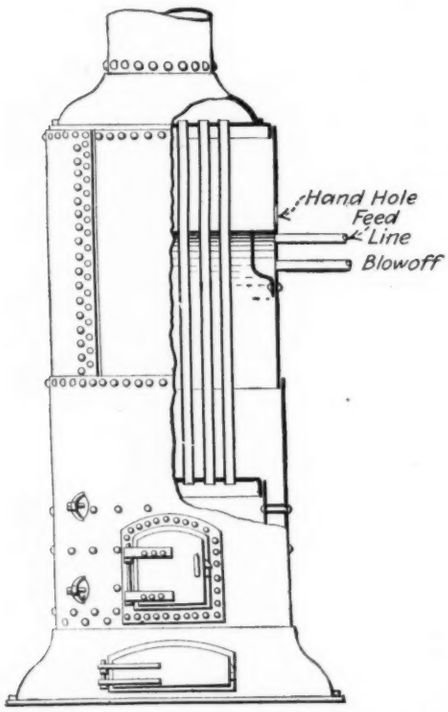
Case No. 253 (Previously Annulled)—Inquiry: Is it permissible under the requirements of the Boiler Code to use for boiler construction, tubes or flues that have been formed into the desired lengths by welding together at their ends, short lengths of such tubing by the electric pressure welding process, provided the metal upset at the weld is immediately rolled down to the proper thickness while under the heat of the weld?

Reply: It is the opinion of the committee that while there is no objection to the safe-ending of tubes for fire-tube boilers by a suitable welding process, the suggested method of making the tube from a number of small pieces would be an objectionable practice. The committee does not consider the practice of safe-ending of tubes to be suitable for water-tube boilers.

Case No. 268 (Reopened)—Inquiry: (*a*) Inasmuch as the discharge of feed water into vertical fire-tube boilers in accordance with the requirement of Par. 316 of the Boiler Code has caused serious difficulties from leaky tubes in the lower tube sheet, a reconsideration is requested of Case No. 145, in which the opinion of the Boiler Code Committee is given that the discharge of feed water in the water leg of a vertical fire-tube boiler is not permissible.

(*b*) In case it is ruled that such discharge of feed water into the water leg of a vertical fire-tube boiler is not allowed, is it permissible to protect the feed-water discharge through a feed-water pocket riveted within the shell at a point above the water leg, with handhole opening for cleaning?

Par. 316. Feed water shall not discharge in a boiler close to riveted joints in the shell or to furnace sheets.



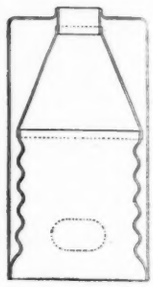
CASE 268 ARRANGEMENT OF FEED INLET IN VERTICAL BOILER

Reply: (*a*) It is the opinion of the committee that Par. 316 does not permit of discharging the feed water in the water leg of a vertical fire-tube boiler, and that difficulties with leaky tubes may be avoided by the use of an internal feed pipe which does not discharge into the water leg.

(*b*) It is the opinion of the committee that such a method of delivery of feed water to a vertical tubular boiler through an internal pocket or baffle above the water leg, with handhole opening for cleaning, is in full accordance with the requirements of the Boiler Code.

Case No. 275—Inquiry: Is autogenous welding permissible for the longitudinal joint of the firebox of a form of vertical boiler as shown in the illustration, where the furnace section is, after welding, heated and corrugated by rolls? The corrugations are rolled to a depth of 1½ in. on 8-in. centers, and the weld shows no fracture or distress after either corrugating or flanging.

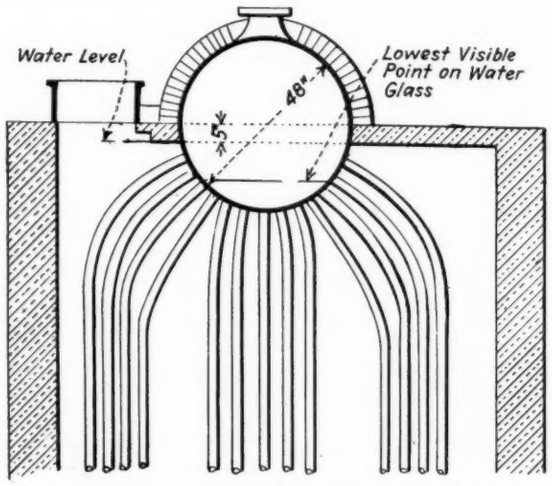
Reply: It is the opinion of the committee that the construction referred to, fully complies with the requirement of Par. 186 of the Boiler Code.



CASE 275. SPECIAL FIREBOX

Par. 186. Welded Joints. The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq.in., with steel plates having a range in tensile strength of 45,000 to 55,000 lb. per sq.in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

Case No. 278—Inquiry: What would be considered the lowest permissible water level for a vertical water-tube boiler of the type shown in the illustration? Par. 430*v* of the Boiler Code to which reference is made in Par. 291 relative to the lowest permissible water level, leaves the location rather problematical, as there may be a difference in opinion as to what the lowest permissible water level may be.



CASE 278. SHOWING SPECIAL DESIGN OF WATER-TUBE BOILER

Par. 291 provides that each boiler shall have at least one water-gage glass, the lowest visible part of which shall be not less than 2 in. above the lowest permissible water level. The lowest permissible water level for various classes of boilers shall be the location for the fusible plug as given in Par. 430 of the Appendix.

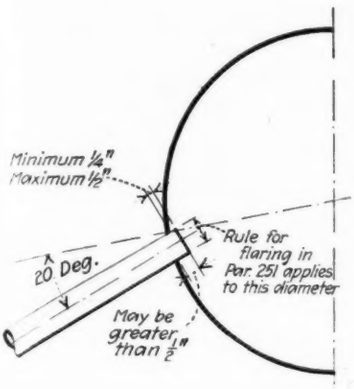
Par. 430, after providing for the location of fusible plugs in various standard types of boilers, provides, "For other types and new designs, fusible plugs shall be placed at the lowest permissible water level, in the direct path of the products of combustion, as near the primary combustion chamber as possible.

Reply: It is the opinion of the committee that for a water-tube boiler of the design illustrated, a location for the

lowest permissible water level such as referred to in Par. 430*i* would be a suitable and safe construction.

Par. 430*i*. In Stirling boilers, superheater type—(the location of the fusible plug) in the front drum, not less than 6 in. above the bottom of the drum, exposed to the products of combustion, and projecting through the sheet not less than 1 inch.

Case No. 283—Inquiry: In the construction of a water-tube boiler in which the tubes enter the tube sheet at an angle as great as 20 deg. from the normal, may the requirements of Par. 252 of the Boiler Code be fulfilled if the least projection of the tube be not less than ¼ in. and the maximum not more than ½ in.?



CASE 283. OBLIQUE TUBE IN WATER-TUBE BOILER

Par. 252 provides that the ends of all tubes, suspension tubes and nipples of water-tube boilers and superheaters shall project through the tube sheets or headers not less than ¼ in. nor more than ½ in. before flaring.

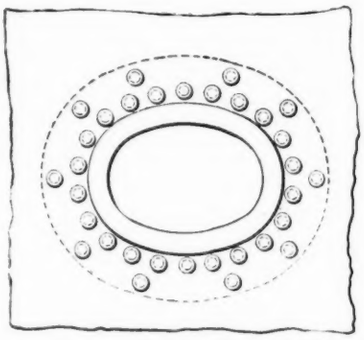
Reply: It is the opinion of the committee that Par. 252 applies to tubes which enter normally to the sheet and that where the tubes are at an angle, the least projection of the tube should be not less than ¼ in. or more than ½ in., which may result in the tube projecting more than ½ in. at other points. The rule given in Par. 251 for flaring should apply to the true diameter of the tube hole measured in a plane at right angles to the tube end and not to the maximum diameter of the elliptical opening in the tube sheet.

Par. 251 provides that the ends of all tubes, suspension tubes and nipples shall be flared not less than ¼ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than ¼ in., rolled and beaded, or flared, rolled and welded.

Case No. 287—Inquiry: Is it permissible to burn off the edges of boiler plates and use them without any finish where sheared edges would be permitted by the rules in the Boiler Code?

Reply: The code does not prohibit the practice suggested.

Case No. 288—Inquiry: Where a manhole is applied to the head of a dome and an opening for access to the boiler is placed in the shell under the dome, is it necessary to reinforce this opening in accordance with the requirements of Par. 260?



CASE 288. REINFORCING RING FOR MANHOLE

Par. 260 provides that manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in the illustration. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

Reply: It is the opinion of the committee that such an opening should be reinforced in accordance with the requirements of Par. 260. The reinforcing effect of the base of the dome may be included in calculating the reinforcement.

Case No. 291—Inquiry: In the case of a special arrangement of spacing of tube holes in the shells of the drums of a water-tube boiler with the pitch unequal in every second row, but shifting the adjoining rows to an exact stagger, as shown in the sketch, is it proper to calculate the efficiencies of ligaments under the requirements of Par. 192 or 193 of the Boiler Code?

Par. 192. When a shell or drum is drilled for tubes in a line parallel to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows:

a When the pitch of the tube holes on every row is equal, the formula is:

$$\frac{p-d}{p} = \text{efficiency of ligament}$$

where p = pitch of tube holes in inches, and d = diameter of tube holes in inches.

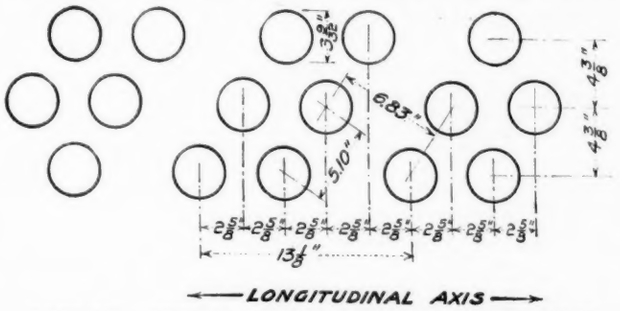
b Where the pitch of the tube holes on any one row is unequal the formula is:

$$\frac{p-nd}{p} = \text{efficiency of ligament}$$

where p = unit length of ligament in inches, n = number of tube holes in length p, and d = diameter of tube holes in inches. Example spacing shown in Fig. 1. Diameter of tube holes $3\frac{9}{32}$ in.

$$\frac{p-nd}{p} = \frac{29.25 - 5 \times 3.281}{29.25} = 0.439, \text{ efficiency of ligament}$$

c. The strength of those ligaments between the tube holes which are subject to longitudinal stress shall be at least one-half



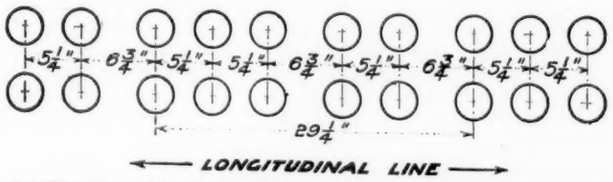
CASE 291. SPECIAL ARRANGEMENT OF TUBE HOLES IN WATER-TUBE BOILER

the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.

Par. 193. When a shell or drum is drilled for tube holes so as to form diagonal ligaments, the efficiency of these ligaments shall be that given by the diagram (diagram given in the Code is too large for reproduction here). In this diagram the abscissas are $\frac{p}{d}$ and the ordinates are $\frac{p'}{p}$, where p = longitudinal pitch of the tube holes in inches, p' = diagonal pitch of the tube holes in inches, and d = diameter of the tube holes in inches.

To use the diagram the values of $\frac{p}{d}$ and $\frac{p'}{p}$ are computed and the efficiency for the corresponding point is read off from the diagram. Should the point fall above the curve of equal efficiency for the diagonal and longitudinal ligaments, the longitudinal ligaments will be the weaker, in which case the efficiency is computed as in Par. 192.

Reply: It is the opinion of the committee that the efficiency of the tube sheet should be obtained by employing the method outlined in Pars. 192 and 193 of the Code for diagonal ligaments. All possible methods of failure should be assumed and the lowest value obtained through any one of the methods, should be used.



CASE 291. ARRANGEMENT OF TUBE HOLES TO ILLUSTRATE EXAMPLE IN PARAGRAPH 192 OF CODE

Case No. 292—Inquiry: In the case of a triple-riveted butt and double-strap joint with the pitch of rivets in the first and third rows one-half of that of the second row, as shown in the illustration, what is the proper method of determining the back pitch between the first, or inner, and second, or middle, rows of rivet holes?

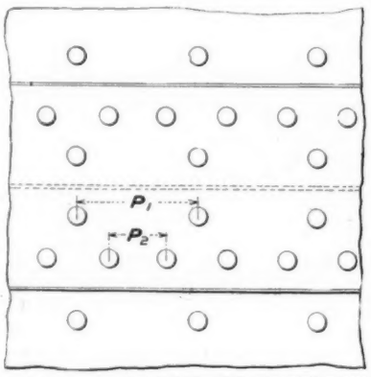
Reply: It is the opinion of the committee that the back pitch required between the first, or inner, and the second, or middle, rows of rivet holes in such a design of joint shall be governed by the rules of Par. 182 for determining the back pitch between the second and third or outer rows of rivets.

Par. 182. The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a. If $\frac{P}{D}$ is 4 or less, the minimum value shall be 2 *D*.

b. If $\frac{P}{D}$ is over 4, the minimum value shall be: $2D + 0.1\ (P - 4D)$

where P = pitch of rivets in outer row, where a rivet in the inner row comes midway between two rivets in the inner row, in inches; P = pitch of rivets in the outer row less pitch of rivets



CASE 292. LAYOUT OF RIVETS IN JOINT DESCRIBED IN INQUIRY

in the inner row, where two rivets in the inner row come between two rivets in the outer row, in inches (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced); D = diameter of rivets in inches.

In the illustration herewith the second value of P should be used; that is, $P = P_1 - P_2$.

Case No. 294—Inquiry: Is it the intent of Par. 331 of the Boiler Code that at least one complete set of the four stamps specified for boiler plate in Par. 36 remain visible after the completion of the boiler, or if the slab or melt number is invisible, are the remaining markings sufficient to meet the Code requirements?

Par. No. 36. Marking. *a.* Each plate shall be legibly stamped by the manufacturer with the melt or slab number, name of manufacturer, grade and the minimum tensile strength of the stipulated range as specified in Par. 28, in three places, two of which shall be located on diagonal corners about twelve inches from the edge, and one about the center of the plate, or at a point selected and designated by the purchaser so that the stamp shall be plainly visible when the boiler is completed.

b. Each head shall be legibly stamped by the manufacturer in two places, about twelve inches from the edge, with the same marks in such a manner that the stamp is plainly visible when the boiler is completed.

c. Each butt strap shall be legibly stamped by the manufacturer in two places on the center line about twelve inches from the end with the same marks.

Par. No. 331. Stamping of Boilers. In laying out shell plates, furnace sheets and heads in the boiler shop, care shall be taken to leave at least one of the stamps, specified in Par. 36 of these rules, so located as to be plainly visible after the boiler is completed; except that the tube sheets of a vertical fire-tube boiler, and butt straps shall at least have a portion of such stamp visible sufficient for identification when the boiler is completed.

Reply: It is the opinion of the committee that all the information which the Code requires to be stamped on the plates at the mills must be obtainable from the finished drum structure for each plate. All four stamps need not be visible at a given point if the fragments from various sets can be pieced together so as to give the desired information.

Case No. 295—Inquiry: How may an inspector in the field know the range of tensile strength of boiler plate? Is it not customary for the boiler-plate manufacturer to state the range on the test sheets furnished to the purchaser?

Reply: Attention is called to the fact that the range for all classes of steel specified in the Code is 10,000 lb. per sq.in., and the tensile strength stamped on the plate indicates the minimum of this range, which minimum under the rules must not exceed 55,000 lb. per sq.in.

Case No. 296—Inquiry: Will a water-tube boiler of a type largely used in marine service, the heating surface of which is constructed mainly of iron pipe screwed into malleable iron and steel fittings, meet the requirements of the Boiler Code, if the pipe used is a special quality of redrawn lap-welded iron pipe of puddled stock and tested to 1,000 lb. hydraulic pressure?

Reply: There is nothing in the Boiler Code to cover the use of iron pipes for the tubes of such a boiler with screwed joints. Until such a time that the specifications for piping have been formulated, the Boiler Code Committee would consider that if the other requirements of the Boiler Code are met, special redrawn pipe not to exceed 1¼-in. standard pipe size made from lap-welded iron of puddled stock and tested to 1,000 lb. hydraulic pressure, may be used for a working pressure not to exceed 200 lb. per sq.in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers.

Case No. 297—Inquiry: Will the requirements in the Boiler Code for automatic water gages be met under the terms of Par. 427*e*, if the shutoff valve in the upper fitting has a projection which pushes the ball away from the seat for a distance of ⅛ in., causing the ball to drop to a position considerably greater than ½ in. away from its seat?

Par. No. 427. Automatic shutoff valve on water gages, if permitted to be used, shall conform to the following requirements: (a) Check valve in upper and lower fittings must be of the solid non-ferrous ball type to avoid corrosion and the necessity for guides . . . (e) The shutoff valve in the upper fitting must have a projection which holds the ball at least ¼ in. away from its seat when the shut off valve is closed.

Reply: It is the opinion of the committee that the intent of the requirements of the Code will be met in the construction described.

Case No. 298—Inquiry: Is it permissible in the case of a forged-steel steam outlet riveted to the boiler shell to use a wrought-steel flange screwed to the outer end of the end-neck, the neck being properly threaded and peened over into a beveled part cut away from the flange?

Reply: It is the opinion of the committee that this method of forming a steam outlet connection meets the requirements of the rules in the Boiler Code.

Supply Lines for Gas Engines and Other Large Appliances

The piping code of the National Fire Protection Association, approved at the May, 1920, convention, includes the following recommendations regarding supply lines for gas engines. These rules will doubtless form a portion of the National Board of Fire Underwriters' insurance requirements and building piping.

The pipe to supply gas to a gas engine or other appliance of large consumption or high momentary demand shall, in every case, be carried back far enough independent of other piping, or other provision be made, to insure that the pressure at the other appliances is not disturbed by the operation of this appliance. Before the installation of the pipe for a gas engine is begun, consultation with the gas company is recommended, and the following precautions should be observed whenever practicable:

1. Every gas piping system should be of adequate size and so designed as to give as nearly equal distribution as possible, and in large installations a circulating system is recommended to give a more uniform pressure throughout.

2. Piping and connections shall be run as directly as possible.

3. Gas bags, if used to supply high momentary demand and maintain constant pressure, must be inclosed in a substantial gastight metal drum of approved construction, vented to the outer air through a pipe used for no other purpose, and the outer end have protected turned-down fitting to prevent clogging.

4. When not otherwise provided for, the regulator should be arranged with an automatic gas shutoff to prevent the flow of gas into the room in case the engine shuts down from any cause.

A perpetual right to the water-power resources of the Skagit River, Washington, as a source of power for municipal light and power purposes in Seattle has been given the city by the United States Government. The city is now engaged in the preliminary work on a project for the development of 50,000 hp., the cost of which is estimated at $7,000,000 and which it is believed will prove to be one of the best water-power projects in Washington, furnishing ample power for operation of street car lines, street lighting and an immense surplus for sale to private consumers.

Electric Power for Pumping*

BRIEFLY stated, the advantages commonly claimed for electric-motor-driven pumps are low operating expense, low first cost, compactness and simplicity, flexibility as to location, cleanliness, sturdiness and ease of control.

Operating expenses include such items as energy or fuel, attendance, supplies and the repairs necessary to maintain the machinery in operating condition. Most electric-motor-driven pumps require very little attention as there are no parts exposed to high temperatures and the lubrication is accomplished by ring oilers or other devices which require only occasional inspection. The pumps are frequently located in remote wellhouses and visited daily or weekly, as the case may be, for inspection; the operation being controlled either manually from the power house or central office, or automatically by a pressure-controlled switch. The great saving in labor costs constitutes one of the most important advantages of motor-driven pumps. In a small installation the energy costs are usually lower than the cost of the fuel that would be required by a steam plant. This is true despite the fact that coal is used to generate the electrical energy in the first place and that this energy must be carried over a transmission line and used in a motor. The reason for this is that with a steam plant considerable fuel is lost in getting up steam, banked fires, steam leakage and other boiler losses. Also direct-acting steam pumps commonly used in such plants take steam the full length of stroke and are very inefficient as compared with the large steam turbines commonly used in central power stations. With most types of motor-driven pumps supplies and maintenance expenses are lower than with steam pumps because of the greater simplicity of the pumping equipment.

The first cost of a plant is important because upon it the fixed charges—interest, depreciation, insurance and taxes—are dependent. These charges form an important item in the cost of service. The first cost of a motor-driven pumping plant is low because electric motors operate at high speed and therefore are small considering the power they develop. Also, they do not require a boiler plant and are more compact in construction than steam equipment. The building for housing the pumping plant is much smaller and costs a great deal less than one necessary to house a steam plant.

Where the water is pumped from widely separated deep wells, the advantage of flexibility becomes important, as a motor-driven pump can be placed at each well and controlled from a remote point either manually or automatically.

Probably the greatest objection urged against the electric motor is lack of reliability. This objection is based largely on the fact that the electric motor is not a prime mover, but is dependent for its energy supply over a transmission line from a central station. The electric motor itself, if properly applied, is the most reliable of all driving powers. This has been demonstrated many times in recent years in all sorts of service ranging in variety from clock mechanisms to battleships.

Even when the risks incident to transmission line or central-station breakdown are taken into account, electric drive compares favorably with a steam plant equipped with a single boiler and pump. Furthermore, electric-service interruptions are usually of only a few hours' duration at most and are therefore not of as great importance as the breakdown of a steam boiler. In some localities other difficulties, such as variable voltage or frequency or high cost of power service, arise. These difficulties are particularly likely to occur where the source of power supply is a small local plant.

DATA ON MOTOR-DRIVEN PUMPS IN THE STATE OF INDIANA COLLECTED ON INSPECTION TRIPS, 1919

Town	Population	Total Head	Annual Pumpage Million Gal.	Annual Energy Consumption Kw.-Hr.	Kw.-Hr. per 1000 Gal.	Kw.-hr. per 1000 Gal. per 100 Ft. Head	Total Annual Operating Cost Dollars	Operating Cost per 1000 Gal. Cents	Operating Cost per 1000 Gal. per 100 Ft. Head Cents
A	13,000	115	300*	383,300	1.28	1.11	14,603.58	4.86	4.23
B	10,000	484	478	1,565,000	3.28	0.68	15,174.11	3.20	0.66
C	8,700	212	422.4*	307,130	0.73	0.34	14,000	3.31	1.56
D	3,800	150	36*	52,800*	1.47	0.98	1,210.23	3.36	2.24
E	2,500	102	69.8	64,810	0.93	0.91	2,411.05	3.45	3.38
F	2,400	136	66.83	75,140	1.12	0.825	3,849.56	5.76	4.24
G	2,400	160	646.25*	129,250	0.20	0.125			
H	1,900	100	43.08	58,300*	1.35	1.35	1,494.51	3.50	3.50
I	1,600	120		98,455			6,263.60		
J	1,400	100	55.1	60,000*	1.09	1.09	1,634	2.97	2.97
K	1,400	132	18*	27,912	1.55	1.17	658.24	3.66	2.77
L	1,300	106	30*	8,230	0.27	0.25	263.30	0.88	0.83
M	1,200	148	43.12	100,000*	2.32	1.57	3,850	8.93	6.05
N	1,200	120		5,878			329.23		
O	1,100	137		5,888			333.55		
P	1,100	125	10.9*	26,740	2.45	1.96	1,835.14	16.83	13.5
Q	800	144	13*	3,770	0.29	0.20	515.20	3.96	2.75
R	600	145		13,330			805		

* Estimated

Average kw.-hr. per 1000 gal.	1.31
Average kw.-hr. per 1000 gal. per 100 ft. head	0.90
Average operating cost per 1000 gal. in cents	4.97
Average operating cost per 1000 gal. per 100 ft. head in cents	3.74

The energy required by a motor-driven pump is usually expressed in kilowatt-hours per 1,000 gal. of water pumped. This is not a very satisfactory measure of performance as pumps work between wide ranges of suction lifts and discharge heads and therefore the energy requirements differ greatly. For large low-head pumps the energy required may be as low as 0.4 kw.-hr. per 1,000 gal., and for small high-head pumps it may be as high as 10 kw.-hr. per 1,000 gal. For average conditions in the small plants of the State of Indiana, 1.25 kw.-hr. per 1,000 gal. seems a fair figure. A better measure of performance is the amount of energy required to lift 1,000 gal. of water 100 ft. In an analysis of actual operating performances given in the table, both of these measures of performance are used.

The annual cost of energy for a given plant depends quite as much on the cost per kilowatt-hour as on the amount of energy used. Rates vary through a wide range, being dependent on the size, kind and location of the central power station. Also they may be affected by the nature and magnitude of the energy requirements of the load. They usually contain a charge more or less dependent on the aggregate horsepower of the customer's motors as well as an energy charge, these charges being graded in accordance with the magnitude of the customer's requirements.

For the plants visited, 25 in towns ranging from 500 to 25,000 population, the average cost per kilowatt-hour for the year 1918 varied from 0.8c. to 5c. The lower cost obtained in a fairly large town which received its energy supply from a hydro-electric plant transmission line, while the higher one prevailed in several towns receiving their energy from small local plants. An average for all the towns is about 3c. per kilowatt-hour. In several instances the power-company employees took care of the pumping plant, the

*Abstract from Bulletin No. 4 (100 pages), "The Application of Electric Motive Power to Small Waterworks Plants in Indiana," by D. D. Ewing, professor of electric railway engineering, and G. C. Blalock, instructor of electric engineering, Purdue University. Published by Engineering Experimental Station, Purdue University, Lafayette, Ind.

attendance charges being included in the energy rate. In two towns the energy charge was based on the pumpage, as for example, 5c. per 1,000 gal. of water pumped. In the main this is neither a very fair nor a satisfactory method of paying for energy.

Since the cost of electric energy ordinarily depends on the nature of the demand as well as on the actual amount of energy used, a study of the nature of the demand which a pumping station imposes on a power house is of interest. It costs much less per kilowatt-hour to furnish energy to a motor that runs steadily with a uniform load 24 hours per day than where it runs only a few hours per day. Also, energy used during periods when the power plant is not carrying its heaviest load—off-peak energy as it is usually called—can be purchased cheaper than used during the peak-load period of the day. The power demand of a water plant with a given pumpage will depend upon the kind of water system and the type of pumps used. Where the pressure of the mains is maintained directly by the pumps, the power input will be almost constant, while in those plants where the pumps operate only a few hours per day while filling a storage tank, the power demand will be intermittent in character and in general will be larger than with the other system.

The coal consumed in pumping water in small plants with steam pumps is about five times that necessary to generate the electrical energy required to pump the same amount of water with motor-driven pumps. The energy consumption in properly designed plants for conditions obtaining in the State of Indiana may be expected to vary from 0.5 to 3.0 kw.-hr. per 1,000 gal., 1.25 kw.-hr. per 1,000 gal. being a fair average. The corresponding energy consumption per 1,000 gal. per 100 ft. of head varies from about 0.2 to 2.0 kw.hr., with 1.0 as a fair average. The first cost of an electrically operated pumping plant is from 25 to 50 per cent of that of a steam pumping plant. The operating expenses for an electrically operated plant are less than 50 per cent of those for a steam-driven plant and are appreciably lower than those for an internal-combustion engine driven plant.

An Improved Form of Weir for Gaging in Open Channels

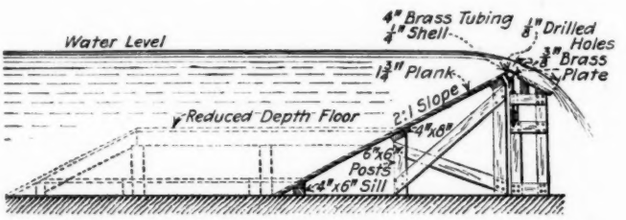
In a paper presented by Clemens Herschel before the American Society of Mechanical Engineers at the Spring Meeting in St. Louis, May 27, 1920, an improved form of weir for gaging in open channels is discussed and an account of experiments with this weir is given. The proposed form of weir is designed to eliminate the disturbances caused by the stream of water suddenly meeting a vertical obstruction and being torn by a sharp-edged crest. It was hoped, and the hope appears to have been realized, that such a construction would yield a formula much more simple than those at present used. The experiments made indicate that the discharge in cubic feet per second per foot in length of weir is represented by the straight line formula,

$$Q = 5.50d$$

where Q is the discharge and d is the difference of two observations of water height or pressure. One of these observations is taken upstream from the weir and is corrected, either automatically or by computation, for velocity of approach, and the other is taken at the crest of the weir.

The experiments described were made at the Hydraulic Laboratory of the Massachusetts Institute of Technology, using two weirs, one 10 ft. long and the other 3 ft. long. The flow of water was measured by a 30-in. venturi meter for experiments using more than about 8 cu.ft. per sec. and by a 16-in. venturi meter for smaller quantities. Variations of velocity of approach were obtained by introducing false bottoms, or "reduced depth floors," into the weir box to diminish its cross-sectional area.

The general design of the weir is shown in the illustration. The water is led gently up to the crest by a 2 to 1 slope. The crest itself is made in the form of the arc of a circle, and instead of bothering about air under the nappe, the nappe is supported on another 2 to 1 slope downstream from the crest. In this case the crest is made of a 4-in. diameter tube having a series of ⅛-in. holes so that the pressure of the water at the crest may be measured. Trial tests showed that best results were obtained when these holes were bored at right angles to the upstream slope of the weir. Connection from this tube with a hook-gage pail enabled the height of water over the crest or, more properly, the pressure due to the action of the water on the pizometer orifices, to be read. The height of the water upstream was read in a hook-gage pail having an orifice flush with the flume side, 13.9 ft. upstream from the weir crest



PROPOSED FORM OF WEIR FOR USE WITH SIMPLE FORMULA

and 1.68 ft. below it in elevation. For the same reasons that a vertical faced weir is objected to, end contractions were eliminated.

A pitot-tube orifice pointing upstream was also arranged to measure the upstream head so as to automatically correct for the velocity of approach. Faulty apparatus and the limited time available rendered the readings on this device worthless so the readings of the regular hook gage were corrected by computations.

As a result of these experiments the author concludes that with a weir of the proposed shape the straight-line formula given may be used over the range of 0 to 9.55 cu.ft. per sec. per ft. of weir length and probably for greater quantities. Further experiments are suggested to determine the effect, if any, of changes in the radius of the crest, and the value of the pitot-tube orifice for obtaining the upstream head. The factor 5.50 used in the equation is also subject to further experimental investigation, especially to determine logical reasons for its value.

The Puget Sound Power and Light Co. has registered in the office of the county auditor a new mortgage covering approximately $25,000,000 of its assets made to the Boston Safe Deposit and Trust Co., of Boston, and at the same time registered a release of a mortgage covering about the same amount previously given to the Old Colony Trust Co., also of Boston. Each document was presented in printed form and embraced the description of the multitudinous holdings of the company, requiring over a hundred pages of closely printed matter. The series of transactions cited in the new mortgage cover the financial history of the company through its several reorganizations and recognition as an asset the $15,000,000 worth of municipal bonds received from the City of Seattle when that city acquired the part of the system which lies within its limits. One object of the mortgage was stated to be to secure the release of $14,301,000 of these utility bonds of the City of Seattle, now held in trust by the Boston Safe Deposit and Trust Co. The new designation of the company appears in the instrument as the Puget Sound Power and Light Co. The amount of filing fees collected on the two documents was $142.05.

Charles Freeman, original locator of the power site, whose rights were later acquired by the city of Seattle, Wash., has located two other power sites below the site which the city of Seattle is building upon, one of them capable of developing 20,000 hp. and the other one 10,000 hp. Mr. Freeman declines to state in whose interests he is acting or what he or his associates propose to do with the sites, beyond saying that they will be developed.

Official figures for British coal production in 1919 are 329,743,000 tons, as compared with 227,741,000 tons in 1918 and 284,412,000 tons in 1913.

Engineers in Westminster Abbey

I did not know that there was in Westminster Abbey a well-defined location for the tombs and monuments of scientists and engineers. We all know of Poets' Corner and of the Royal Chapels which contain the bones of many of England's kings and queens. But the engineers' and scientists' corner (an inadequate description for one spot in the quiet nave and in the north aisle) has not been celebrated in the descriptions of the abbey that have come to my hand. Consequently I was the happier at the discovery.

Against the screen of the choir stalls, looking in the nave is the monument of Sir Isaac Newton, while directly in front, well out in the center of the nave, are the tombs, under the pavement, of Telford and George Stephenson—Telford's marked by one of the small square pavement stones cut with his name; Stephenson's by a full length floor panel, a work of art in bronze. A statue of Telford stands elsewhere in the abbey. What a place for a last resting place! What a fitting home for the long sleep of these master engineers! Above them springs the wonderful Gothic nave, airy in its lightness, yet built of stone—a sight such as I have never seen. The master builders of a later age lie asleep beneath the work of the master builders of all time, masters who outrivaled those of ancient Egypt or Greece or Rome—the Gothic cathedral builders of the Thirteenth Century. Egypt built great temples and mighty pyramids. So did Greece and Rome. But structurally the forms were simple. With the high-flung naves and crossings and choirs of the Middle Ages came engineering problems of no mean order. Yet so well were the principles understood that wonderful grace and appearance of lightness were secured. Today, with all our advances, we do nothing to equal their master works.

But to return to the engineers in Westminster.

By the side of Newton, directly in front of the Newton monument, lies the body of the late Lord Kelvin, while twenty feet to the north, in the aisle, lie, side by side, the bodies of Herschel the astronomer and of Charles Darwin. Above these graves, casting on them a light mellowed by the art of the stained-glass worker, are a memorial window to Sir Benjamin Baker, the inscription recording two of his great works—the Forth Bridge and the Assuan Dam, and another to Lord Kelvin, "Engineer and Natural Philosopher," as the inscription has it. In this same north aisle are memorial windows, also, to Stephenson, Joseph Locke, designer of the Crewe Engine; Brunel, Trevithick, and Charles William Siemens.

The Siemens window looks down on a group of tablets to scientists—to Lister, the physician; Darwin; Hooker, the botanist; Adams, the astronomer, and Joule, the physicist. The Joule tablet bears this inscription: "This tablet is here placed near the graves of Newton, Herschel and Darwin by those who in many lands have united to perpetuate the memory of James Prescott Joule, F. R. S., of Manchester, in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat."

In the central part of the nave and the north aisle are buried other great men with kinship to engineers. We find the tomb of Sir Charles Lyell, the geologist. It is covered by a brass-lettered slab bearing this tribute: "Throughout a long life he sought the means of deciphering the fragmentary records of the earth's history, in the patient investigation of the present order of nature, enlarging the present boundaries of knowledge and leaving on scientific thought an enduring influence." Out in the center of the nave, near the graves of Telford and Stephenson, are four graves placed with singular appropriateness under this great nave—mortal remains of four architects who played an important part in the revival of Gothic architecture. They are Sir Charles Barry, architect of the Houses of Parliament; Sir George Gilbert Scott, George Edmund Street and John Loughborough Pearson.

As I turned to leave this part of the abbey, after musing there an hour, I chanced to walk over the Telford inscription and my eye caught on the slab at Telford's feet the name of Livingstone—David Livingstone, the African explorer; and the thought struck me that he was in kindred company. He explored an unknown country; he extended the bounds of knowledge regarding a section of the earth's surface. So did Telford and Stephenson and Lyell explore the unknown; so did they and their great fellow engineers and scientists about them extend the bounds of knowledge. They, no less than he, were explorers of a dark continent and have placed humanity under tribute for all time.

*Excerpt from a letter written by E. J. Mehren, editor of *Engineering News-Record*, recording some impressions gained abroad.

Inquiry Into Coal Situation by Senate Committee

Charging that great quantities of American coal were being exported to European countries despite the embargo on fuel exports, James J. Storrow, State Fuel Administrator of Massachusetts, offered testimony at the opening of the inquiry of the Senate Committee on Reconstruction and Production, Tuesday, July 20, at the Engineering Societies Building. The hearing was conducted by Senator William M. Calder, the only member of the committee present.

Mr. Storrow declared that the coal embargo put into effect some time ago on order from the Interstate Commerce Commission was not being enforced and that the industries of the country would soon face paralysis unless measures were taken to stop the flow of American coal to Europe. Mr. Storrow said that the American market is overrun with European buyers who are offering such high prices for coal that no American buyers can outbid them. In Boston Harbor coal is being offered for from $20 to $21 per ton, while in the instance of one ship the price was $23.

Last April, the first month following the original lifting of all restrictions on coal exports by the fuel administration, there was shipped to Hampton Roads 1,900,000 tons of coal. Of this 1,300,000 tons was sent abroad and only 600,000 tons was distributed throughout this country, causing such a shortage that New England was forced to get along on half her normal coal supply.

The second session of the hearing was held Wednesday afternoon, July 21. John F. McGee, of Minneapolis, and State Fuel Administrator of Minnesota, appeared before the committee in response to a subpœna, for the purpose of giving information as to the conditions in the coal situation in the Northwest. Mr. McGee for some time has been in the City of Washington, keeping in close touch with developments.

In answer to questions put to him by the committee, Mr. McGee declared that the situation was becoming more acute in the Northwest each year and that while the demands of this territory for coal were increasing continually, less coal was being obtained with which to meet them. "In the past few years," said Mr. McGee, "a remarkable development has taken place in this section of the country. A vast number of power plants and industries have begun operations and it is necessary that they be supplied with coal." Mr. McGee was emphatic in his statements, laying the blame on car shortage at the mines. He said that at the present time the Northwest was facing a coal shortage totaling 6,000,000 tons compared to the same month last year and that American industries over the Canadian border from Minnesota were taking an additional 6,000,000 tons per annum. He declared, however, that the deficit could be made up if a sufficient number of cars were delivered to the mines and various other transportation difficulties were overcome.

William H. Groverman, of Minneapolis, who held the position during the war of District Representative of the United States Fuel Administration and who at the present time is secretary to the Northwest Coal Dock Operative Association, was next called upon and questioned regarding the situation in the Northwest. His testimony confirmed the statements made by Mr. McGee and he gave it as his opinion that the situation was becoming more serious each day and that unless something was soon done the industries in that section of the country would suffer seriously.

Increase in Rates for Electricity

The Pacific Gas and Electric Co. has been authorized by the Railroad Commission to increase its rates for electricity by the addition of a 15 per cent emergency surcharge to apply on all bills rendered beginning with July 10, 1920, and ending with April 10, 1921, a period of nine months. Similar authority has also been granted the Great Western Power Co. The commission's decision adds to the standard rate schedules of both companies the surcharges that have been allowed on previous applications, the emergency percentage increase granted being imposed on the combined rates.

The effect will be a 15 per cent increase over the amounts that have been collected in recent months. In the case of the Pacific Gas and Electric Co. it is estimated that the new emergency rate will produce additional revenue of $2,200,000 for the year ending July 1, 1921.

The increase in rates applies to all territory served by the Pacific Gas and Electric Co., including that operated under lease from the Sierra & San Francisco Power Co. and the territory recently acquired through the purchase of the properties of the Northern California Power Co. In the case of the Great Western Power Co. the commission directs that company to bring to the level of its other rates its charges for municipal street lighting, street-railway power and power sold to other public utilities, which three classes of service were exempted when surcharges were fixed in July, 1918.

Councilmen William Hickman Moore and R. H. Thomson, of Seattle, Wash., conferred Tuesday, July 13, with officials of the Puget Sound Light and Power Co. to ascertain if the company would be able to furnish the city with power in case the lack of fuel oil should cause the municipal light and power plant at Lake Union to reduce materially the current it is furnishing to Seattle consumers. According to officials of the city light department, the supply of fuel oil on hand will suffice to operate the Lake Union plant only until the end of July. Negotiations are under way at the present time to obtain an oil tanker from the United States Shipping Board to transport oil to Seattle for the city's use. In the event that no relief can be obtained in that way, it has been proposed to obtain current from the traction company during the off-peak hours, so that the water in Cedar Lake, the source of the city's hydro-electric power at the Cedar Falls plant, may be conserved for use during the peak hours.

Personals

Howard C. Adams, formerly chief estimator for Tate-Jones & Co., Inc., has joined the George J. Hagan Co., of Pittsburgh, as engineer in their liquid fuel department.

W. S. Quigley, president of the Quigley Furnace Specialties Co., sailed for France on the Cunard liner "Imperator," on July 15. His trip is for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

Charles W. Oakley, of Passaic, N. J., has accepted a position in Trenton, N. J., as supervising engineer of the G. R. Cook plants. Mr. Oakley will supervise the construction of a new plant and will devote much time to improving the efficiency of some of the old ones.

Timothy Healy was elected by the American Federation of Labor at the recent convention as one of the two delegates to represent the American labor movement at the British Trades Congress in London, England, next September. His many friends and associates, desirous of manifesting the esteem in which he is held, have arranged for a testimonial banquet to be held at the Yorkville Casino on Wednesday evening, Aug. 11.

P. C. Fordyce, has been appointed superintendent for the West Penn Power Co. at Waynesburg, Pa., succeeding W. T. McCormick who has been transferred temporarily to the securities sales department. Mr. Fordyce, who is a native of Waynesburg, has been with the West Penn for eight years in various capacities, having been located at Monongahela City, Butler, Kittanning and at the Pittsburgh office. He comes to his new position from the power sales department.

Society Affairs

The Michigan Section of the National Electric Light Association will hold its annual convention Aug. 24-26, at the Hotel Ottawa, Ottawa Beach, Michigan. It is expected that the consolidation of the Michigan Section with the Western Geographic Division will be arranged at that time.

The Grand Council Universal Craftsmen, Council of Engineers, will hold its annual convention at Springfield, Mass., Aug. 3-6, and in connection the annual exhibition of power-plant machinery, accessories and supplies will be conducted during the day and evening under the direction of the Craftsmen. The entertainment committee of the Council has planned many events and features of interest for the delegates and visitors.

The Public Relation Association of the National Electric Light Association at its first meeting in Chicago in July, which was for the purpose of organizing, discussed in a general way the work to be covered and postponed organization until Aug. 1, due to the fact that all geographic divisions were not represented. The work will be divided and subcommittees appointed at that time to handle every phase of public-relations work.

The Report of the Ontario Branch of the Canadian Manufacturers' Association shows that serious consideration is being given to development of water power in Quebec sufficient to fill the needs of the manufacturers. A number of resolutions were adopted urging remedial measures to be at once conducted by the Hydro-Electric Power Commission and especially requesting that no more radical railway projects be entered upon until sufficient power is on hand to fill manufacturers' requirements.

Miscellaneous News

The Board of Directors of the Industrial Relations Body at their annual reorganization meeting at Atlantic City elected J. M. Larkin, of Pennsylvania, president; Mark M. Jones, vice-president; F. C. Parker, Chicago, Ill., secretary, and W. H. Winans, New York City, treasurer.

Premier Foster, of New Brunswick, has announced the appointment of the following to comprise the Hydro-Electric Commission for New Brunswick: Honorable C. W. Robinson, St. John, N. B.; C. O. Foss, St. John, and Ried MacManus. The commission will proceed immediately with the development of water power.

The Bureau of Standards, in following up the investigation of lead-covered cable failures in St. Louis, has sent out a number of inquiries to railway and power companies asking whether in their experience lead-covered cables fail more frequently when installed in fiber conduits than when installed in other types of conduit with particular reference to cables carrying power at 2,200 volts or higher.

The Radio Corporation of America is about to begin construction on the largest radio station in the world, on the north shore of Long Island near New York City. The project will be known as the New York Radio Central Station and will be able to simultaneously send and receive messages from five great nations of other continents. Preliminary engineering surveys have been completed, contracts for all construction material have been let, and a force of radio experts will immediately begin work.

The Division of Power Resources of the Geological Survey, in statistics covering the production of electric power and consumption of fuel by public-utility plants in the United States for the first four months of 1920, shows that New York State leads in hydro-electric output, the monthly total for that state reaching 268,736,000 kw.-hr. for April against 292,336,000 kw.-hr. produced by fuel. California ranks second by water power, with 219,475,000 kw.-hr. for April. Montana comes third with 100,008,000 kw.-hr. and Washington fourth, with 95,672,000 kw.-hr.

The Public Service Corporation of New Jersey has indefinitely postponed construction of the 200,000-kw. power station for which a twenty-five million dollar corporation had been planned. Prime factors in stopping the proposed construction are the extremely high prices of fuel, labor and cost of material. The company is having difficulty in obtaining fuel for present requirements, and it was pointed out that the operation of a power plant of the size contemplated would increase the amount of fuel consumed from 25 to 50 per cent. Under present conditions it would be impossible to obtain the necessary amount of fuel.

Trade Catalogs

The Hi-Voltage Equipment Co., Cleveland, Ohio, has ready for distribution a new 16-page catalog entitled "Hi-Voltage." It contains descriptions and illustrations of air-brake switches, horn-gap fuses, choke coils, etc. A copy of the catalog will be sent upon request.

"Portable Floor Cranes and Hoists" is the title of a new 34-page catalog now ready for distribution by the Canton Foundry & Machine Co., of Canton, Ohio. Complete descriptions of the portable floor cranes and hoists handled by this company are contained in the booklet, together with illustrations. A copy can be had on request.

"Power Machinery" is the title of a new 48-page catalog now ready for distribution by McGovern & Co., Inc., of New York. A complete classified list of power machinery, including air compressors, electric cables, condensers, cranes, compound and simple engines, feed-water heating, alternating-current and direct-connected generators, gas and oil engines, turbines, etc., is given. A copy of the booklet will be sent on request.

The Buffalo Forge Co., engineers and manufacturers, of Buffalo, N. Y., have published a new 51-page catalog entitled "Niagara Conoidal Fans." It contains tables of performances that should prove valuable to engineers and architects in making selections to meet any demands encountered in ordinary heating and ventilating practice. Complete descriptions, accompanied by illustrations of the various types of fans handled by this company, are also contained in the booklet. A copy will be sent on request.

Bituminous Coal on the Atlantic Seaboard

Soft coal is much in demand and now that buyers will pay a price more nearly competitive with export business, the coal comes forward, at $17 to $20, according to a recent payment for southern coal f.o.b. car at Boston, plus whatever charges accrue. Even the high volatiles are being readily absorbed and with the railroads still endeavoring to get a supply of fuel, there is no likelihood of a decline in prices. A reasonably large proportion of New England coal is coming in on contract. A few industrial plants are in serious difficulties.

Current quotations for bituminous at wholesale range about as follows:

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$10.50@$11.75	$11.50@$13.00
F.o.b. Philadelphia, gross tons	13.60@ 15.00	14.75@ 16.50
F.o.b. New York, gross tons	14.00@ 15.40	15.10@ 16.85

The improvement in car supply in parts of the Clearfield region and the conferences that have been held in New York by committees of railway executives and bituminous operators have led many to believe that the peak in prices has been reached. It was estimated that there were about four thousand cars of coal at the various loading docks on July 16, of which twenty-five hundred had been reported to the New York Tidewater Coal Exchange. Quotations at the mines on pools 1, 9 and 71 range from $13 to $14 with little being offered; pool 10, around $12.50; pools 11 and 18, $11.75 to $12.50, and pool 34, $11.75. Quotations, f.o.b. piers, range from $16 to $16.25 and from $17 to $17.25 alongside docks.

Despite reports of a better car supply, Philadelphia prices remain high. Pennsylvania steam coal sells at from $12.50 to $14 at mines, with a little tonnage of ordinary steam coal, mostly pool 18, offered around $12. The Westmoreland and Youghiogheny gas coals are reported to be selling anywhere from $13 to $15 a ton at the mines, with Fairmont coals somewhat lower, $12.50 at the mines being the average for all grades.

At Baltimore there is the greatest congestion of coal carrying vessels in the history of the ports. At or off the Curtis-Day pier are fifty-three ships to take on a total of about three hundred thousand tons of coal, while at the Canton pier are seven or eight vessels ready for fifty thousand tons. Loadings coastwise and for export by permit are being pushed and in the first part of July there was a total export loading of 150,000 tons, of which 135,000 was cargo coal. At tide, however, there is only some 2,000 cars of coal, with about the same number moving from the mines, so that all the coal in sight at this moment cannot load the waiting ships promptly. At the mines the usual procedure is for the purchasers to make their offers and the producers to accept the highest. Coal is selling at the present time, on which the consumer has not been billed and is trusting that he will be charged a fair price. Sales at the mines of best coal have been generally $11 to $13 per net ton.

New Construction

PROPOSED WORK

N. H., Portsmouth—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Aug. 11 for removing and reconstructing boiler and stokers. Noted July 20.

Mass., Watertown—Lockwood, Greene & Co., Archts. and Engrs., 60 Federal St., Boston, will soon receive bids for a 1 story, 200 x 230 ft. foundry including a steam heating system for the Walker & Pratt Mfg. Co., 31 Union St., Boston.

Conn., Bristol—The School Comn. will receive bids until Aug. 3 for a 3 story high school including a steam heating system at Dunbar Meadows. About $750,000. Wilson Potter, 22 East 17th St., New York City, Archt.

Conn., Hartford—St. Francis Hospital will soon award the contract for a 3 story hospital including a hot water heating system on Woodland St. About $500,000. Sister Valencia, Superior.

Conn., Waterbury—The Connecticut Military Emergency Bd., State Armory, Hartford, will soon award the contract for a 4 story, 180 x 200 ft. armory including a steam heating system on Field St. About $400,000. Louis A. Walsh, 51 Leavenworth St., Archt.

Conn., Westport—E. T. Bedford, Greens Farms, will soon award the contract for a 2 story Y. M. C. A. building including a steam heating system on State St. About $250,000. W. B. Tubby, 81 Fulton St., New York City, Archt.

N. Y., Annandale—Stephens College plans to construct a college building including a steam heating system. About $600,000. Hoppin & Koen, 4 East 43rd St., New York City, Archts. and Engrs.

N. J., Garfield (Passaic P. O.)—The Bd. Educ. will receive bids about August 15 for a 2 story, 83 x 150 ft. school including a steam heating system on Lincoln Pl. About $225,000. A. L. Vegliante, Archt.

Pa., Philadelphia — Congress, Wash., D. C., appropriated $270,000 for the completion of the power plant including the installation of equipment at the Frankford Arsenal here and $88,000 for the installation of high tensioned electrical transmission lines from the power plant to the shops.

Pa., Philadelphia — The Temple University, 18th St. and Buttonwood Ave., is having plans prepared for a 6 story, 300 x 300 ft. college building including a steam heating system on Montgomery and Broad Sts. About $500,000. Philip H. Johnson, 1713 Sansom St., Archt. and Engr.

Pa., Scranton—The Bour Refractories Co., Laurel Line and Front St., plans to construct a 3 story, 90 x 200 ft. refractory including a steam heating system on Stafford Ave. About $300,000.

D. C., Washington — Congress appropriated $6,500 for the installation of new boiler tubes and mechanical stokers at the Columbia University for the Deaf.

Va., Richmond—A. G. Jones, 1418 East Main St., is having plans prepared for a 7 story, 70 x 150 ft. furniture warehouse including a steam heating system. About $400,000. Moores & Dunford, 38 South Dearborn St., Chicago, Archts.

Va., Richmond—The Transportation Motor Co., 1410 West Broad St., is in the market for a motor.

N. C., Four Oaks—The Ivanhoe Mfg. Co. plans to build mill 3 here. Plans include a warehouse and small heating plant. J. E. Sirrine, Greenville, S. C., Engr.

Miss., Magnolia—Jarvis A. Kramer plans to construct a 100 ton ice and cold storage plant.

La., New Orleans—The Packers' Architectural and Engineering Co., Archts. and Engrs., 431 South Dearborn St., Chicago, will soon award the contract for a 2 story, 100 x 198 ft. main building, 1 story, 57 x 67 ft. power house and a 2 story, 24 x 36 ft. reduction plant for the Arabi Packing Co. About $400,000.

Ky., Louisville—The Columbia Realty Co., c/o Arland W. Johnson, Archt., 469 5th Ave., New York City, plans to construct a theatre including a steam heating system. About $700,000.

O., Cleveland—St. Alexis Hospital plans to construct a 4 story hospital addition including a steam heating system on B'way and McBride Ave. About $450,000. C. A. Grasselli, Chn. of the Bldg. Comn. W. C. Jansen, Electric Bldg., Archt.

O., Cleveland—The Theodore Butcher Co., 2129 West 19th St., is in the market for a 20 hp. horizontal boiler (new or used).

O., Cleveland—The Walter Ice Co., c/o A. C. Bishop, Archt. and Engr., Guardian Bldg., is having plans prepared for the construction of a 1 story, 45 x 146 ft. ice plant on West 25th St. About $75,000.

O., East Cleveland (Cleveland P. O)—The East Cleveland Bd. Educ. will receive bids until July 30 for a 1 story, 48 x 66 ft. heating plant including two 300 hp. boilers. About $100,000. C. Ammerman, Clk. W. H. Nicklas, 1900 Euclid Ave., Cleveland, Archt.

O., Elyria—The Bd. Educ. plans to build a 2 story school including a steam heating system on Gulf St. About $250,000. R. S. Silsber, Lorain County Bank Bldg., Archt.

Ind., Fort Wayne — The Jackson Township School, Allen Co., plans to install a 3 kw., 110 volt generator, driven by a gasoline or kerosene engine, a 500 gal. per hour pump, driven by a 1 hp., 110 volt motor, with automatic control and to maintain a pressure of 50 lbs. per sq in. in a pressure tank, a 2 pipe modulation system of direct indirect steam heating and ventilating. Separate bids for installing lighting and power plant, heating and ventilating, etc., will be received. F. G. Fortney, 509-510 Bass Blk., Archt.

Ind., Indianapolis — The Bd. of School Trustees plans to install a steam heating system in the proposed 2 story school on Talbot Ave. Cost, $250,000. And in the proposed school on Martindale Ave. Cost $425,000.

Ind., Indianapolis—R. Hassler, 1435 Naomi St., is in the market for three 12,000 gal. capacity pumps, compressor and a blower to be installed in the proposed pump house at Hassler Polo Field.

Ind., Syracuse — The Wawassee Tire & Rubber Co., c/o R. L. Simmons, Archt., Elkhart, is having plans prepared for a 4 story, 175 x 175 ft. factory including 4 tubular boilers. About $600,000.

Mich., Bay City—The city is having preliminary plans prepared for the construction of a new filtration plant and reservoir and changing pumping system. About $2,000,000. Frazier-Elmo-Shaw Co., 1223 Illuminating Bldg., Cleveland, O., Engrs.

Mich., Detroit—The Comr. of Pub. Wks. will soon award the contract for furnishing and installing six mile road pumps and motors including one 8 ft. and one 10 ft. vertical centrifugal motor driven pumps, one 25-30 hp. motor for 8 ft. pump and one 40 hp. motor for 10 ft. pump.

Mich., Mt. Pleasant—Congress, Wash., D. C., appropriated $30,000 for a power and heating plant at the Indian School here.

Ill., Breese—The city plans to construct a 2,200 volt, 3 phase a.c. electric power line from here to Ariston including transformer stations, poles, etc. Fuller & Beard, Chemical Bldg., St. Louis, Mo., Engrs.

Ill., Chicago — Henshein & McLaren, Archts., 37 West Van Buren St., will soon award the contract for a 3 story, 115 x 170 ft. packing plant including a steam heating system on West 39th St. and Emerald Ave. for David Levi & Co., West 40th St. and Packers Ave. About $350,000.

Ill., Chicago — W. Kelly, c/o George C. Nimmons & Co., Archt., 122 South Michigan Ave., is having plans prepared for a 9 story, 75 x 100 ft. office building including a steam heating system at 546-48 South State St. About $500,000.

Wis., Florence—C. R. Johnson, Secy. Committee on Waterworks Improvements, will receive bids until Aug. 15 for furnishing 3 centrifugal motor driven pumps from 100 gal. to 500 gal. capacity, 2 operating panels equipped with automatic controllers, meter and oil switches, one electric siren and one small air compressor. W. G. Kirchoffer, 316 Vroman Blk., Engr.

Minn., Argyle—The city plans to build an extension to a high power transmission line from here to Crookston and install an electric light and power system. About $30,000. E. A. Brekke, City Clk.

Minn., Minneapolis—The State Bd. of Control, Capitol, St. Paul, is having plans prepared for a 4 story administration building including a steam heating system on the State University campus, here. About $1,000,000. C. H. Johnston, 715 Capitol Bank Bldg., St. Paul, Archt.

Minn., St. Paul—The Bd. Educ., City Hall, received bids for installing heating and ventilating system in the proposed 3 story, 64 x 96 ft. school on Lafond and Avon Sts., from the Hankee Heating Co., 925 Merchants' Natl. Bank Bldg., $14,108; O'Neil Plumbing & Heating Co., 97 East 8th St., $19,993.

Minn., St. Paul—The Bd. Educ., City Hall, received bids for installing a steam heating system in the proposed 2 story, 60 x 128 ft. addition to school on Hamline St. between Jefferson and Lansing Sts., from The Hankee Heating Co., 925 Merchants' Natl. Bank Bldg., $14,814; O'Neil Plumbing & Heating Co., 97 East 8th St., $15,983.

Kan., Lawrence—Congress, Wash., D. C., appropriated $20,000 for improving the heating and power plant at the Haskell Institute here.

Mont., Rockcreek—The state plans to construct a power plant to have a capacity of 20,000 kw. here.

Mont., Ronan—The state plans to construct a power plant on the Indian Reservation near here.

N. D., Fargo—E. G. Guthrie, Clk., will soon award the contract for a 2 story, 63 x 168 ft. junior high school, including a steam heating system for the Bd. Educ. About $110,000.

Mo., St. Louis—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., received bids for a boiler plant at the Marine Hospital here, from William Wilby, Selma, Ala., $4,000; Werner Hencke Plumbing Co., 2335 South Grand St., $4,095; Elliott & Barry Eng. Co., 1426 Olive St., $4,115. Noted July 7.

Tex., Brownwood—McCully & Co. is in the market for power equipment.

Tex., San Benito — The Cameron Co. Water Improvement Dist. 2 will receive bids until July 29 for furnishing 1 Diesel or Semi Diesel engine and centrifugal pump of sufficient capacity to deliver 100,000 gal. of water per min. discharging against a variable head up to 20 ft. Address F. S. Robertson, Genl. Mgr.

N. S., Halifax—The City Council voted $70,000 bonds to install a water meter system and new pumping station.

N. B., St. John—The York Cotton Mills will receive bids until August 1 for the electrification of its plant here and is in the market for equipment. Cost, over $100,000.

Ont., Kenora — The Lake of the Woods Pulp Mill Co. plans to develop the water power here. About $1,000,000.

Ont., London—The Columbia Handle Co. plans to install a steam plant and is in the market for engine, boiler and equipment. W. H. Braddon, Genl. Mgr.

Ont., London—George M. Reid, 391 Clarence St., will receive bids until August 21 for a 16 story, 100 x 180 ft. hotel including a steam heating system on Richmond St. About $1,500,000.

Ont., London—The Utilities Comrs. are having plans prepared for a new power dam at Springbank. About $200,000. Equipment will be installed in same. E. V. Buchanan, Hydro Bldg., Genl. Mgr.

CONTRACTS AWARDED

Mass., Fall River—The New England Oil Co. will build 6 buildings, including a 24 x 40 ft. addition to boiler house along the Taunton River here. About $100,000. Work will be done by day labor.

Mass., Foxboro—The City has awarded the contract for the installation of central plant steam mains, etc., in the Foxboro State Hospital, to the Power Heating & Ventilating Co., 66 Travers St., Boston, at $13,055. Noted July 13.

Mass., Somerville — The Sturtevant & Haley Beef & Supply Co., 40 Fanueil Hall, Boston, has awarded the contract for the 2 story, 25 x 60 ft. refrigeration plant on Somerville Ave. to Harold H. Clark, 10 Dearborn Rd. About $20,000.

R. I., Cranston—The Narrangansett Finishing Co. has awarded the contract for a 1 story, 45 x 65 ft. boiler house addition to the C. I. Bigney Constr. Co., 357 Westminister St., Providence, at $30,000.

N. Y., Kings Park — Lewis F. Pilcher, State Archt., has awarded the contract for the installation of heating, etc., at the Kings Park State Hospital, here, to W. B. Armstrong Co., 3 Fulton St., Albany, at $124,000. Noted June 1.

Pa., Scranton—Linder Bros. have awarded the contract for a 3 story, 90 x 160 ft. garment factory including a steam heating system and electric power on Capouse and Poplar Sts., to the E. A. Fuller Co., Dickson Ave., at $160,000. One hundred electric motors will be installed in same.

O., Cincinnati—The Union Gas & Electric Co., 4th and Plum Sts., has awarded the contract for a 1 story, 65 x 95 ft. electrical substation at 220 West 8th St. to the Foundation Co., Front and Rose Sts., at $40,000.

O., Cleveland—The Cleveland Electric Illuminating Co., Illuminating Bldg., has awarded the contract for a 2 story, 36 x 49 ft. substation addition at 1753 East 17th St., to F. E. Hauselman, 408 Illuminating Bldg., at $60,000.

Ind., Indianapolis—McCoy & Garten, 518 South Senate St., has awarded the contract for a 6 story, 81 x 190 ft. warehouse including boilers, etc., on South St., to the Bedford Stone & Constr. Co., Fletcher Saving & Trust Bldg., at $300,000.

Ind., Indianapolis — The Pioneer Brass Wks., 424 South Pennsylvania St., has awarded the contract for a 1 story, 200 x 300 ft. factory including boilers on 23rd St. and the Lake Erie Western R.R., to John G. Karstedt Constr. Co., 429 Lemcke Bldg. About $200,000.

Ill., Chicago—The Ajax Forge Co., 2503 Blue Island Ave., has awarded the contract for three 1 story buildings including a small boiler shop on Hoyne and Blue Island Aves., to Charles B. Johnson & Son, 111 West Washington St., at $300,000.

Wis., Colby—The Hoeppner-Bartlett Co., Eau Claire, will build a canning factory including a 2 story, 42 x 166 ft. main building and a 20 x 56 ft. boiler house.

Wis., Madison—The State Bd. of Control has awarded the contract for a power house at the State Home for Women to the Immel Constr. Co. Fond du Lac, at $26,483.

Minn., Hallock—The village has awarded the contract for furnishing power plant equipment, to J. G. Robertson, University and Eustis Sts., St. Paul, at $24,463.

Minn., Kennedy—The Kennedy Electric Line Co., Inc., has awarded the contract for a 15 mi. transmission line from here to Hallock, to the Triumph Electrical Co., Minneapolis, at $10,724.

Minn., Minneapolis — The Lincoln Motor Sales Co., 219 Metropolitan Bank Bldg., has awarded the contract for installing a heating and ventilating system in the proposed 66 x 145 ft. sales and service building on 12th St. and Harmon Pl., to Charles Wilkins & Co., 214 South 7th St., at $16,640.

Minn., Minneapolis — The Northwestern Terminal Co., 1217 Soo Line Bldg., has awarded the contract for installing a heating and electric system in the proposed 3 story, 100 x 200 ft. warehouse on Stinson Blvd. and B'way, to Harry C. Ridler, 3842 Pleasant Ave.

N. D., Grand Forks—The Industrial Comn. of North Dakota has awarded the contract for a reservoir, power house and plant including boilers, stokers, etc., to the Fegles Constr. Co., Minneapolis. Noted May 25.

Neb., Lincoln—The Bd. Educ. has awarded the contract for the installation of a heating system in the proposed Prescott School, to Phelps Underwood, at $77,545.

Wash., Seattle—The city has awarded the contract for the completion of the third unit to the Lake Union steam plant at Eastlake and Nelson Pl., to the Hurley Mason Co., Lowman Bldg. About $200,000.

Cal., San Diego—The Naval Pub. Wks. Office received only bid for refrigerating equipment and cold storage installation at the marine brigade post here, from the York Constr. Co. of Los Angeles, 308 Boyd St., Los Angeles, $34,500.

Que., La Tuque—The Brown Corp. Ltd. is in the market for 1 belt driven, forced draft fan, to have a 45,000 cu.ft. per min. capacity at 5 ft. pressure and one 12 x 15 ft. storage tank.

Ont., Toronto—The Grinnell Co., Ltd., has awarded the contract for a 1 story, 100 x 150 ft. foundry building including motors and a forced draft heating system, etc., to the Anglin Norcross Co. Ltd.

NEED COMPETENT MEN?

SEE THE SEARCHLIGHT SECTION

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